ACCURACY OF BRACKET POSITIONING IN DIRECT AND INDIRECT BONDING TECHNIQUE

Dissertation Submitted to

THE TAMIL NADU DR. M.G.R. MEDICAL UNIVERSITY

in Partial fulfilment for the degree of

MASTER OF DENTAL SURGERY

BRANCH - V
ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS
APRIL – 2013

CERTIFICATE

This is to certify that the dissertation entitled **"Accuracy of Bracket Positioning in Direct and Indirect Bonding Technique"** by **Dr. C.Jegan kumar** Post graduate student (M.D.S), Orthodontics (branch V), Tamil Nadu Govt. Dental College and Hospital, Chennai, submitted to the Tamil Nadu Dr. M.G.R. Medical University in partial fulfilment for the M.D.S. degree examination (April 2013) is a bonafide research work carried out by him under my supervision and guidance.

Guided by

DR. G. VIMALA M.D.S.,
Professor,
Dept. of Orthodontics and dentofacial orthopedics,
Tamil Nadu Govt Dental College & Hospital,
Chennai - 600 003.

Dr. M.C.SAINATH M.D.S.,
Professor and Head of the Department,
Dept. of Orthodontics&dentofacial orthopedics
TamilNadu Govt. Dental College & Hospital,
Chennai - 600 003.

Dr. K. S. G. A. NASSER M.D.S.,
Principal ,
TamilNadu Govt. Dental College&Hospital,
Chennai- 600 003.

DECLARATION

I, Dr. C.JEGAN KUMAR , do hereby declare that the dissertation titled "ACCURACY OF BRACKET POSITIONING IN DIRECT AND INDIRECT BONDING TECHNIQUE" was done in the Department of Orthodontics, Tamil Nadu Government Dental College & Hospital, Chennai 600 003. I have utilized the facilities provided in the Government Dental College for the study in partial fulfilment of the requirements for the degree of Master of Dental Surgery in the speciality of Orthodontics and Dentofacial Orthopaedics (Branch V) during the course period 2010-2013 under the conceptualization and guidance of my dissertation guide, Professor Dr. G. VIMALA M.D.S.

I declare that no part of the dissertation will be utilized for gaining financial assistance for research or other promotions without obtaining prior permission from the Tamil Nadu Government Dental College & Hospital.

I also declare that no part of this work will be published either in the print or electronic media except with those who have been actively involved in this dissertation work and I firmly affirm that the right to preserve or publish this work rests solely with the prior permission of the Principal, Tamil Nadu Government Dental College & Hospital, Chennai 600 003, but with the vested right that I shall be cited as the author(s).

Signature of the PG student

Signature of the HOD

Signature of the Head of the Institution

ACKNOWLEDGMENT

My sincere thanks to Dr. K.S.G.A. NASSER, M.D.S., Principal, Tamil Nadu Government Dental College and Hospital, Chennai-3, for his kind support and encouragement.

I owe my thanks and great honour to Dr. M.C. SAINATH M.D.S, Professor, Head of the Department, Department of Orthodontics and Dentofacial Orthopaedics, Tamilnadu Govt. Dental College and Hospital, Chennai3, for helping me with his valuable and timely suggestions and encouragement.

I express my deep sense of gratitude and great honour to my respected guide, Professor Dr. G. VIMALA M.D.S., Department of Orthodontics and Dentofacial orthopaedics, Tamilnadu Govt. Dental College and Hospital, Chennai-3, for her patience guidance, support and encouragement throughout the study.

I owe my thanks and great honour to Dr. S. PREMKUMAR M.D.S, Professor, Department of Orthodontics and Dentofacial Orthopaedics, Tamilnadu Govt. Dental College and Hospital, Chennai3, for helping me with his valuable and timely suggestions and encouragement.

I am grateful to Dr. B. BALASHANMUGAM, M.D.S., Assistant Professor, Department of Orthodontics, Tamil Nadu

Government Dental College and Hospital, Chennai –3 for his support and encouragement.

I am grateful to Dr. USHA RAO, M.D.S., Assistant Professor, Department of Orthodontics, Tamilnadu Government Dental College and Hospital, Chennai-3 for her support and encouragement.

I am grateful to Dr. K. USHA, M.D.S., Assistant Professors, Department of Orthodontics, Tamil Nadu Government Dental College and Hospital, Chennai –3 for her support and encouragement.

I thank Mr. K. BOOPATHI M.Sc., M.Phil, for helping me with the Statistics in the study.

I take this opportunity to express my gratitude to my friends and colleagues for their valuable help and suggestions throughout this study.

I offer my heartiest gratitude to my family members for their selfless blessings.

I seek the blessings of the Almighty God without whose benevolence; the study would not have been possible.

TRIPARTITE AGREEMENT

This agreement herein after the "Agreement" is entered into on this day.....day of December 2012 between the Tamil Nadu Government Dental College and Hospital represented by its **Principal** having address at Tamilnadu Government Dental college and Hospital, Chennai-03, (hereafter referred to as , 'the college')

And

Dr. G. VIMALA aged 44 years working as professor at the college, Having Residence address at AP 115, 5th Street, AF Block, 11th Main Road, Anna Nagar, Chennai, Pin: 600 040, India (herein after referred to as the 'Principal Investigator')

And

Dr. C. JEGAN KUMAR aged 27 years currently studying as postgraduate student in department of Orthodontics in Tamilnadu Government Dental College and Hospital (herein after referred to as the 'PG/Research student and co- investigator').

Whereas the 'PG/Research student as part of his curriculum undertakes to research on **"Accuracy of Bracket positioning in Direct and Indirect bonding technique**" for which purpose the PG/Principal investigator shall act as principal investigator and the college shall provide the requisite infrastructure based on availability and also

provide facility to the PG/Research student as to the extent possible as a Co-investigator.

Whereas the parties, by this agreement have mutually agreed to the various issues including in particular the copyright and confidentiality issues that arise in this regard.

Now this agreement witnesseth as follows:

1. The parties agree that all the Research material and ownership therein shall become the vested right of the college, including in particular all the copyright in the literature including the study, research and all other related papers.

2. To the extent that the college has legal right to do go, shall grant to licence or assign the copyright do vested with it for medical and/or commercial usage of interested persons/entities subject to a reasonable terms/conditions including royalty as deemed by the college.

3. The royalty so received by the college shall be equally by all the parties.

4. The PG/Research student and PG/Principal Investigator shall under no circumstances deal with the copyright, Confidential information and know – how generated during the course of research/study in any manner whatsoever, while shall sole vest with the manner whatsoever and for any purpose without the express written consent of the college.

5. All expenses pertaining to the research shall be decided upon by the principal investigator/Co-investigator or borne sole by the PG/research student.(co-investigator)

6. The college shall provide all infrastructure and access facilities within and in other institutes to the extent possible. This includes patient interactions, introductory letters, recommendation letters and such other acts required in this regard.

7. The principal investigator shall suitably guide the student Research right from selection of the Research Topic and Area till its completion. However the selection and conduct of research, topic and area research by the student researcher under guidance from the principal investigator shall be subject to the prior approval, recommendations and comments of the Ethical Committee of the college constituted for this purpose.

8. It is agreed that as regards other aspects not covered under this agreement, but which pertain to the research undertaken by the student Researcher, under guidance from the Principal Investigator, the decision of the college shall be binding and final.

9. If any dispute arises as to the matters related or connected to this agreement herein, it shall be referred to arbitration in accordance with the provisions of the Arbitration and Conciliation Act, 1996.

In witness whereof the parties hereinabove mentioned have on this the day month and year herein above mentioned set their hands to this agreement in the presence of the following two witnesses.

College represented by its **Principal** **PG Student**

Witnessess **Student Guide**

1.

2.

CONTENTS

LIST OF TABLES

Abstract

Background

Pre adjusted edgewise appliances have inbuilt tip, torque and anti-rotation elements. As they incorporated in the bracket itself, final tooth positioning is mostly influenced by the initial bracket positioning. Hence, bracket positioning must be precise and minor deviation can affect the final tooth positioning adversely.

Objective

To compare the direct and indirect bracket bonding techniques to identify the bonding technique which enables the most accurate bracket positioning.

Materials and Method

30 patients were selected and were divided into Group A and Group B. In Group A direct bonding in 1^{st} and 3^{rd} quadrants and indirect bonding in 2^{nd} and 4^{th} quadrants were planned. Group B receives bonding in opposite way. Brackets were placed according to Roth prescription. Dual Transfer tray was prepared with light body and putty C-silicone. Sondhi rapid set resin was used for indirect bonding. Photographs of all anterior teeth with brackets were taken after complete bond up in standardized manner. These photographs were analysed with GIMP 2.8.2 software for errors in bracket height, mesiodistal position and angulation with magnitude and direction.

Results

Errors in vertical and mesiodistal positioning were statistically significant between direct and indirect bonding technique. Though angulation errors exist in both techniques, they were not statistically significant between these techniques.

Conclusion

Both direct and indirect method doesn't possess ideal bracket placement. But indirect bonding shows better precision in vertical and mesiodistal positioning compared to direct bonding. The indirect bonding procedure could provide efficient bracket placement in significantly lesser chair side time, which overweighs the cost involved in the laboratory procedure.

INTRODUCTION

Orthodontic treatment aims at achieving functional occlusion, facial aesthetics and stability of the treatment results. These goals are achieved by orthodontic or orthopaedic corrections depending on the nature of dentoalveolar and skeletal derangements. In most cases, it is the orthodontic repositioning of teeth, achieved through fixed orthodontic appliances. Fixed orthodontic appliances have better delivery and control of prescribed force and therefore offer excellent opportunity for controlled tooth movement.

Edgewise appliance, introduced by Angle in the year 1928 is the prototype of present day's fixed orthodontic appliances. Edgewise brackets were welded on bands and cemented over teeth. As the edgewise brackets had neutral slots, tip torque and rotation of each tooth was achieved by complex wire bending.

Lawrence Andrews introduced the concept of incorporating tip and torque into each bracket, after a thorough understanding of requisites of an ideal occlusion. These brackets were designed in such a way that, when all teeth are aligned in an ideal arch position, a rectangular arch wire would passively fill the full slot of all the brackets. Hence precise positioning of each bracket in a prescribed place became the utmost important determinant in achieving desired treatment goals.

With introduction of composites[46], directly attaching a bracket in a specific position on tooth surface became possible. This 'direct bonding technique' eliminated a medium of a band between bracket base and tooth surface and could directly transmit the intended force.

Due course in 1972, 'indirect bonding technique'[19] was suggested by Silverman & Cohen. With introduction of newer composites with improved properties, indirect bonding technique is now becoming popular.

Direct bonding technique has the advantage of being simple and economical. This technique requires no special armamentarium or lab support. The disadvantage of this technique is that it requires more chair side time and limited visibility makes access and positioning of brackets especially on posterior teeth difficult. Indirect bonding technique overcomes the disadvantages of direct bonding technique. It consumes less of chair side time and precise positioning of brackets is possible. Requirement of lab work and additional expense incurred are the disadvantages of indirect bonding technique.

As both direct and indirect bonding techniques have equal advantage and disadvantages, there exists a need to identify the most suitable bonding technique. Studies reported so far to identify the most preferred bonding procedure are fewer and have not thrown enough light on this subject.

Hence this study was aimed at identifying the best bonding technique by comparing the accuracy of bracket positioning done by direct and indirect bonding techniques.

Aim

The aim of this study was to compare the direct and indirect bracket bonding techniques to identify the bonding technique which enables the most accurate bracket positioning.

Objectives

- ✓ To measure the variation in vertical positioning of brackets in direct and indirect bonding techniques.
- ✓ To measure the variation in horizontal positioning of brackets in direct and indirect bonding techniques.
- ✓ To measure the angular variation in bracket positioning in direct and indirect bonding techniques.

REVIEW OF LITERATURE

Indirect bonding was first described in detail as a concept in 1972 by Silverman and Cohen[19]. Some of the initial trials used softened Sugar Daddy® candy (Tootsie Roll, Inc., Chicago, IL) as a means of attaching the brackets to the working models before transfer tray fabrication. Others have used water-soluble adhesives and even sticky wax to attach the brackets to the models. Eventually this concept evolved to include application of various adhesive-coated brackets as a means of creating custom bases to aid in the bonding process.

Michel Buonocore[36] (1955) introduced acid etching technique for increasing the adhesion of acrylic filling material to the tooth. He used 85% phosphoric acid to etch the tooth surface based on the thought that a simple decalcification that removes the superficial enamel layer is all that is needed to increase the adhesion of acrylic to tooth structure.

Rafael Bowen[46] (1962) discovered a new, stronger resin material for restorative work. The dental filling material consisted of vinyl silane treated fused silica and a binder consisting of the reaction of product of Bis phenol and Glycydyl acrylate.

George Newman[22] (1965) used basics of acid etching technique to attach orthodontic appliances to the teeth for orthodontic treatment. He used polyamide cured epoxy resin and 40% phosphoric acid for enamel conditioning to bond the plastic attachments to tooth surface.

Thomas E. Perkowski[60] (1970) described the clinical and laboratory procedures for indirect method of appliance construction. These appliances include the bands with all attachments precisely placed, arch wires including lingual arches and all retraction assemblies, root springs, extra oral appliances, sutural expansion devices, extra bands for soldered retainers and tooth positioners.

Silverman E and Cohen M[19] (1972) first explained about indirect bonding of brackets. They described the universal direct bonding system for both metal and plastic brackets in which they described in detail about the indirect bonding technique.

Michael D. Simmons[37] (1978) described the use of caramel candy to position the brackets on the model and stated that caramel candy can be washed with hot water from the bracket bases and allows bracket removal from model with all the brackets in transfer tray.

Bjorn U. Zachrisson and Bjiirn Brobakken[14] (1978) conducted a study to compare direct and indirect bonding and stated that direct bonding shows the advantages of (1) better bracket fit to the tooth surface (2) easier to remove excess around the bracket bases (3) the entire contact area of bracket base was constantly filled with adhesive.

Farhad Moshiri, Michael D. Hayward[21] (1979) described about the water soluble, heat resistant resin adhesive to position the brackets on the model. He stated that it allowed the bracket to be embedded in the transfer tray and heat resistant was advantageous during transfer tray fabrication in vacuum pressure.

Royce G Thomas[49] (1979) discussed a modification of the Silverman and Cohen technique in which Concise® (3M Unitek, Monrovia, CA) or Dyna-bond® (3M Unitek) was used to form a custom base. This technique was the first to describe the construction of these custom composite bases, and utilized a two-part liquid sealant to bond the brackets to the dentition with the aid of a clear vacuum-formed transfer tray.

Myrberg, Warner[40] (1982) presented a technique in which individual bracket placement indicators were made for each tooth based on the concept of a dental setup that suits the individual functional, occlusal, and esthetic requirements for each patient.

Barry D. Hoffman[11] (1988) developed an indirect bonding technique that combines the diagnostic setup of tooth positioners with the customized bracket placement and level arch of straight-wire appliances.

Richard A. Hocevar, Howard F. Vincent[47] (1988) found that 44% of the direct bonds fractured predominantly at the bracket-adhesive interface, whereas 72% of the indirect bonds failed mainly at the enamel-resin interface. Thus the indirect bonding promised similar bond strength and easier debonding because less resin was left on the teeth.

Jim W. milne, George F.Anderson[25] (1989) stated that tensile bond strength determinations showed no statistically significant differences between direct and indirect bracket application methods for incisors and premolars. The selection of one bonding method over another may therefore be determined by the accuracy of bracket positioning and the convenience in handling the materials. The indirect method of bonding may result in more consistently accurate bracket placement, especially for the inexperienced operator.

Stephen J. Reichheld, Robert A. Ritucci, Anthony A. Gianelly[54] (1990) used individual preformed height gauges to position the brackets on the working models.

Ronald B. Cooper, Marguerite Goss, Warren Hamula[51] (1992) discussed the advantages of using light-cured adhesives for indirect bonding. He listed several advantages including unlimited working time during bracket placement, less bracket drift on the working models, and less patient discomfort because of the acceleration of bracket bonding.

Ronald B. Cooper, Nile A. Sorenson[50] (1993) described the use of adhesive pre coated brackets in indirect bonding and listed consistency and accuracy of bracket positioning, ease of clean up, and elimination of waste as benefits.

Wolfgang carstenson[63] (1993) conducted a study between 37% and 2% phosphoric acid to find out the bracket failure rate and stated that there was no significant difference in bracket failure between the two groups and 2% of phosphoric acid can be sufficient for the bracket bonding and they showed less adhesive on teeth surface after debonding.

Jing-yi shiau et al[26] (1993) conducted a study to evaluate the bond strength of aged precoated bracket base composite and stated that most failures occur at bracket composite interface rather than enamel composite interface.

Michael J.F. Read, Andrew I. Pearson[38] (1998) discussed the use of a light-cured, lightly filled sealant to attach brackets with a custom resin base to the teeth via an indirect method.

Bon Chan Koo, Chun-Hsi Chung and Robert L. Vanarsdall[13] (1999) conducted a study to evaluate the accuracy of bracket placement in direct and indirect technique and stated that both direct and indirect bonding techniques failed to execute ideal bracket placement. On individual teeth, there was no statistically significant difference in the accuracy of bracket placement between these two bonding techniques.

Larry W. White[31] (1999) used a self-etching primer and a quick cure composite adhesive in indirect bonding. A power slot light-curing tip was used on each of the teeth in the tray for 3 seconds per tooth. This power slot tip is broader at the end and concentrates the light for more rapid curing of the adhesive.

John T. Kalange[27] (1999) presented a technique using vertical and horizontal reference lines on working models for bracket placement based on level marginal ridges, functional occlusal contacts, and esthetic surfaces.

Anoop sondhi[4] (1999) introduced a new resin designed specifically for indirect bonding. He presented a cohesive and complete system for fabricating bonding trays, and the indirect bonding procedure.

Domenico Dalessandri, Michela Dalessandri, Stefano Bonetti, Luca Visconti, Corrado Paganelli[16] (2000) concluded that during the first 4 months after brackets placement, indirect bonding protocol allowed for significant reduction in plaque accumulation around the braces and reduced onset of white spots during the orthodontic treatment.

Birte Melsen, Piero Biaggini[12] (2002) described about Ray Set® (Biaggini Medical Devices, La Spezia, Italy), exemplified the concept of accuracy of bracket placement in indirect bonding by using a sophisticated device to bond preadjusted brackets that reflect individually prescribed requirements for tip, torque, and rotation independent of bracket height or shape of teeth.

Arndt Klocke, Jianmin shi, Ba¨rbel Kahl-Nieke, Ulrich Bismayer[7] (2003) stated that contamination after primer application resulted in an increased risk of bond failure at clinically relevant levels of stress.

T. M. Hodge, A. A. Dhopatkar, W. P. Rock and D. J. Spary[55] (2004) stated that there was no difference between mean bracket placement errors for direct or indirect methods. The range of error in the three directions assessed was greater for direct than indirect placement.

Seung-Min Lim, Ryoon-Ki Hong, Je-Young Park[54] (2004) described a new indirect bonding technique for bonding lingual retainers.

Arndt Klocke, Jianmin Shi, Ba¨rbel Kahl-Nieke, Ulrich Bismayer[8] (2003) used brackets bonded to bovine teeth with multiple indirect techniques involving chemically, thermally, and light-cured composites and direct bonded light cured composites, and found comparable bond strengths for all groups.

Tancan Uysal, Zafer Sari, Abdullah Demir[57] (2004) found statistically significant differences among the groups of flowable composites and conventional orthodontic adhesive. The Shear Bond Strength values were significantly lower in flowable composite groups than the orthodontic adhesive. The use of flowable composites is not advocated for orthodontic bracket bonding because of significantly lower Shear bond strength values achieved.

Arndt Klocke, Drazen Tadic, Farhad Vaziric and Ba¨rbel Kahl-Nieke[5] (2004) stated that pre aging of the custom base composite upto 30 days did not affect shear bond strength and mean bond strength values exceeded 15 MPa. Bond strength measurements for groups with a custom composite base aged for a longer interval (100 days) before sealant polymerization were significantly lower. On the basis of the results of this study, clinicians can safely use custom base composites aged up to 30 days when using the Thomas indirect bonding technique.

William J. Redmond et al[62] (2004) described the use of OrthoCAD® (Cadent, Inc., Carlstadt, NJ), plaster models are sent to a processing department within the company, and stereolithography is used to create a digital model and bracket positioning will be established using a pen-sized wand consisting of a tip, a miniature video camera, and LEDs that allow for a virtual setup.

Arndt Klocke, Jianmin Shi, Ba¨rbel Kahl-Nieke, Ulrich Bismayer[6] (2004) stated that**,** for groups bonded with Maximum Cure or Sondhi Rapid Set sealants, no influence of debonding time on shear bond strength was found. The Custom I.Q. sealant groups showed significantly lower bond strength measurements when debonded at the recommended tray removal time, and higher risk of bond failure at clinically relevant levels of stress. All base composite-sealant combinations showed acceptable bond strength at 30 minutes and 24 hours after bonding of the sealant.

Omu¨ r Pola, Tancan Uysal, Ali Ihya Karaman[42] (2004) stated that indirect bonding of brackets with Sondhi Rapid Set after the application of the antimicrobial varnish showed significantly lower Shear Bond Strength when compared with both the indirect bonding - antimicrobial group, and direct bonded-antimicrobial varnish group.

Eliades and coworkers[18] (2005) validated the importance of reference to marginal ridges versus the centre of the clinical crown as a reference point, when they demonstrated that positioning brackets using the centre of the clinical crown resulted in marginal ridge discrepancy between the premolars and molars and a lack of occlusal contacts with the opposing dentition.

Rohit Sachdeva et al[48] (2005) described the use of SureSmile® (Orametrix, Inc., Richardson TX) ,which is based on a white light intraoral scanner that captures real-time, in vivo images of the dentition. These images can be manipulated in the form of a three-dimensional digital diagnostic setup and can be used to determine the bracket position on teeth.

Fabio Ciuffolo, Ettore Epifania, Gionni Duranti,, Valentina De Luca, Daniele Raviglia, Silvia Rezza, and Felice Festa[20] (2006) stated that Rapid prototyping is a new instrument for indirect bracket positioning. They described the advantages of CAD/CAM technologies to optimize bracket placement and can help the clinician place brackets accurately in a shorter time.

Jacob Daub, David W. Berzins, Brandon James Linn, Thomas Gerard Bradley[24] (2006) stated that the thermocycling process resulted in a significant decrease in Shear Bond Strength. However no significant

difference in Shear Bond Strength was found between teeth bonded directly and indirectly after thermocycling.

Duncan W. Higgins[17] (2007) introduced a tray system which combines clear vinyl polysiloxane to capture the brackets and a thin thermoplastic outer tray. The primary advantage of this technique is the reduction in laboratory time needed to fabricate the hard outer tray.

Samir E. Bishara, Adam W. Ostby, John F. Laffoon and John J. Warren[52] (2007) compared the shear bond strength of orthodontic brackets when the self-etching primer and the bracket adhesive are light cured either separately or simultaneously and found that only one light curing application is needed to successfully bond brackets when using Self Etching Primers and adhesives.

Nir shpack et al[41] (2007) tried to find out the accuracy of bracket placement in Lingual vs. Labial system and concluded that indirect bonding technique was significantly more accurate than the direct technique for all teeth in both labial and lingual orthodontics.

B. Wendl , H. Droschl and P. Muchitsch[10] (2008) conducted a study to evaluate the bond strength of indirect bonding with Aptus bonding device and reported that superimposition of photographs of indirectly bonded upper

labial segment brackets showed no deviations. The results of the 3D measurement of the positions of the brackets on the working and plaster models yielded only small deviations (0.15 mm along the X -axis in the centre, 0.17 mm along the Y -axis, and 0.19 mm along the Z -axis).

Michael A. Thompson, James L. Drummond, and Ellen A. BeGole[35] (2008) tried various methods to prepare the cured composite-adhesive interface for orthodontic indirect bonding and found air abrading orthodontic bracket-pad composite surfaces in indirect bonding increased the shear bond strength, whereas the use of flowable composite did not affect bond strengths.

Philip P. Soo, Brian M. Green and Anoop Sondhi[45] (2009) stated that the white layer defect originated from the formation of an oxygen-inhibited surface layer during curing followed by resin leaching when the bonding tray was rinsed. The fact that this layer does not correspond to the normally observed smooth resin colour surface might be of concern to clinicians; if so, the layer can be eliminated by curing the bonding bases under inert conditions. Moreover, it is not a hindrance to effective bonding.

Takeshi Muguruma, Yoshitaka Yasuda, Masahiro Iijima , Naohisa Kohda and Itaru Mizoguchi[56] (2010) investigated the relationship between the forces applied by the operator and the amount of adhesive used in the direct and indirect bonding methods. A force of greater than 200 grams might

be preferable for obtaining a thin composite resin layer and for achieving sufficient spreading of the composite resin paste.

Mauro Cozzani, Anna Menini, Andrea Bertelli[33] (2010) used etching masks along with the transfer trays that can reduce etchant flash and undesirable enamel conditioning.

Julio P. Cal-Neto , Simone Castro , Pollyana Marques Moura , Daniel Ribeiro ,Jose´ Augusto M. Miguel[28] (2011) found that intraoral sandblasting prior to enamel etching increased the bond strength of lingual brackets, but the clinical performance of the groups was not significantly different.

Anas Al Najjar, Zackary Faber, Richard Faber[2] (2011) described reverse indirect bonding to ease rebonding after a small occasion when the patient wants to temporary debond his or her appliance.

MATERIALS AND METHODS

A total of 30 patients requiring fixed orthodontic treatment in the Department Of Orthodontics and dentofacial orthopedics, Tamilnadu Government Dental College and hospital, Chennai, fulfilling inclusion and exclusion criteria were chosen for the study. Ethical clearance for conducting the study was obtained from the Institutional ethical committee of Tamilnadu Government Dental College and hospital, Chennai. Information about the study was given to and Informed consents were obtained from each patient.

Inclusion criteria

- ✓ Healthy individuals in age group between 12 to 25 years
- ✓ Permanent dentition
- ✓ Patients requiring fixed orthodontic treatment
- ✓ Normal & fully erupted teeth
- ✓ Good mouth opening

Exclusion criteria

- ✓ Worn out / fractured dentition
- ✓ Incisal edge / cusp tip with previous restoration
- ✓ Dentition with unerupted / incompletely erupted teeth
- ✓ Dentition with severe crowding/ abnormal position of teeth which can impede simultaneous bracket placement on all teeth.

- ✓ Malformed / severely hypoplastic teeth
- ✓ Periodontally compromised teeth

Each selected study individual was allotted a number from 1 to 30. Random numbers from 1 to 30 was generated from online random number generator.

The first 15 numbers were grouped as group A and the rest were grouped as group B.

Group A received indirect bonding in 2nd & 4th quadrants and direct bonding in 1st & 3rd quadrants. Group B received direct bonding in 2nd & 4th quadrants indirect bonding in 1st & 3rd quadrants.

Group A	Direct bonding	Indirect bonding
	Indirect bonding	Direct bonding

Group B	Indirect bonding	Direct bonding
	Direct bonding	Indirect bonding

Armamentarium required

- ✓ Roth brackets 0.022”X 0.028” (JJ orthodontics Pvt. Ltd, India)
- ✓ Reverse action tweezer
- ✓ HP marking pencil

- ✓ Boone's gauge
- ✓ Transbond™ XT light cure adhesive and primer (3M Unitek, USA)
- ✓ Plastic Sectional tray
- ✓ Bard parker blade
- ✓ Light cure unit
- ✓ Sondhi rapid set resin type A and B (3M Unitek, USA)
- ✓ Oranwash lightbody condensation silicone (Zermack clinical, Italy)
- ✓ Zetaplus putty condensation silicone (Zermack clinical, Italy)
- ✓ Indurent gel catalyst for C-silicone (Zermack clinical, Italy)
- ✓ Ultrasonic cleaner
- ✓ Unite™ chemical cure bonding adhesive and primer (3M Unitek, USA)
- ✓ Eazetch 37% phosphoric acid etchant gel (Anabond Stedman (P) Ltd, India)
- ✓ Custom fabricated Jig
- ✓ Nikon Coolpix S8200 camera
- ✓ GIMP version 2.8.2 software

Construction of Jig:

A jig was constructed to take photographs in the standardized manner with the camera. Jig was made with 19 gauge round stainless steel wire. One end was made larger to house the camera and on the other end, a diagonal 0.021"X0.025" stainless steel wire was soldered with a step bend.

Method

Markings were done on teeth before bonding procedures according to Roth prescription[61] using Boon's gauge with marking pencil. Bonding of brackets were done as planned in Group A and Group B subjects. Photographs of each incisor, canine were taken using the custom made Jig. The pictures were used to compare bracket height, mesiodistal position and angulations in both groups.

Indirect bonding technique:

Working model preparation:

Upper and lower alginate impressions were recorded and working models were immediately prepared from them.

Markings on the model:

The prepared model was checked for fracture or any defect before placing the measurement lines on the model.

Marking the horizontal line:

Boone's gauge was used to measure the vertical distance between the cusp tip and line drawn along the maximum width of premolar. This vertical distance ('X' mm) was used as reference for determining the vertical reference lines on canine and incisors.

On canine and central incisors, the horizontal line was drawn at a distance of X+1mm from incisal margin. On lateral incisor the line was at the same level of X mm from incisal margin.

These lines determined the vertical positioning of the brackets.

Marking the vertical line:

The long axis of the crown of each tooth was carefully assessed. For premolar and canine the vertical line was drawn along the long axis of the clinical crown on the center of buccal developmental ridge which is the mesiodistal center of the clinical crown. On central and lateral incisors, the mesiodistal center was measured clinically and the line was drawn along the long axis of the clinical crown.

These lines determined the mesiodistal positioning of the bracket.

The brackets were positioned in such a way that the center of bracket slots coincided with the intersection of these vertical and horizontal lines.

Bonding on the model:

After the lines were drawn, one layer of separating medium was applied over the model and allowed to dry. Roth prescription brackets were used for bonding.

Bonding agent was applied on the base of the bracket and light cured. Then, light cure composite was placed on the bracket base and positioned over the tooth. The position was adjusted till it coincides with the reference lines and

fitted on the model with firm pressure. The procedure was repeated for every tooth and the excess composite around the bracket was removed. Once again the bracket positions were verified and each bracket was light cured separately for 20 seconds from occlusal and gingival aspect.

Transfer tray preparation:

After bonding the brackets on model, the transfer tray was prepared with light and heavy body condensation silicone impression material.

The catalyst and base of the light body silicone was dispensed on the paper pad and mixed till the uniform color was obtained. It was applied over the brackets positioned on the model on buccal and occlusal surface and allowed to set. The putty silicone was kneaded between fingers and placed on a plastic sectional tray. This sectional tray was placed carefully over the light body which covered brackets on models and pressed gently. It was allowed to set for 30 min. The excess was trimmed to allow only 3mm of gingival extension of the transfer tray. The model, plastic sectional tray and silicone transfer tray with brackets were removed from each other.

Then the transfer tray was placed in ultrasonic cleaner for 8 minutes to remove any remaining debris on the base of the brackets.

After the transfer tray dried, final light curing of the bracket base was done once again.

Bonding in patient mouth:

Oral prophylaxis without touching the gingival tissues was done just before the bonding procedure. The teeth surfaces were polished with pumice slurry.

Horizontal and vertical ideal reference lines on the teeth surfaces were drawn as described previously to mark the ideal reference lines for bracket placement on model.

Direct bonding

The prepared teeth on the planned quadrants for direct bonding were isolated and etched with 37% phosphoric acid for 15 sec. The etchant was washed with water for 5 seconds. The surface was air dried to get the white frosty appearance. Self-curing primer was applied over the etched enamel surface and bracket base. Then self-cure composite was placed on the bracket base and positioned over the tooth surface and adjusted to position the bracket to align with the reference lines which were drawn previously. The bracket was then fitted with firm pressure and the excess composite was removed.

The same procedure was repeated for each tooth on the other direct bonding quadrant.

Indirect bonding

Tooth preparation, isolation, etching, washing and air drying were done for the indirect bonding quadrants as previously described for direct bonding. Sondhi resin A & B were dispensed in separate dishes. Sondhi resin A was

applied over the prepared teeth surface and sondhi resin B on the exposed bracket base in the transfer tray. The tray was placed carefully in its respective quadrant and held firm for 15 seconds. The tray was removed after 3 minutes with gentle peeling traction starting from palatal surface towards buccal surface. The excess resin around the brackets were removed with hand scaler.

Photograph

Nikon S 8200 camera was used to take the photographs of the teeth with brackets. The photographs were standardized to eliminate measurement errors.

Standardizing and taking the photographs:

Vertical distance from the bracket to the camera lens was standardized with a jig of 110 mm in length. The camera end of the jig housed the camera and outer tooth end was soldered with a diagonal 0.021”X0.025” stainless steel rectangular wire piece with a step bend. This wire step, when placed in bracket slot, ensured that the bracket slot and camera were uniaxial, preventing magnification errors. The photographs were then taken without any zooming. The set of photographs, containing 360 photos was tagged as ‘P1’.

Measurement method using software

GIMP version 2.8.2 software was used to measure the linear and angular measurements from the digital photographs.

For each photograph of P1, a copy P2 was created. The photographs were then imported to GIMP software. The bracket area of the photograph (P1) was

masked with cloning tool of the software. This was to avoid any bias in drawing the ideal reference line in the photograph (P1) due to the presence of brackets.

The pencil markings seen on the photograph (P1), which were previously marked on the teeth just before direct bonding were joined to form horizontal and vertical lines. These were considered as the ideal vertical (V) and horizontal (H) reference lines. The intersection point of these ideal reference lines was considered as the ideal center point (0).

On photograph (P2), the vertical experimental reference line (V') was drawn along the vertical line which was visible on the center of the bracket. The horizontal experimental reference line (H') was drawn along the center of the horizontal slot of the bracket. The intersection of these experimental reference lines was bracket center point (0').

The opacity of photograph (P2) was reduced to 45% of original opacity. The photograph (P2) was superimposed exactly over the photograph (P1), taking tooth margin as reference. This enabled viewing both photographs (P1 & P2) simultaneously and overlapped. The deviation between the ideal and experimental reference lines and center points that were visible was measured.

The deviations were measured with measurement tool in this software. Linear measurements were measured in pixels from this software and were converted to millimeter in pixel to millimeter converter. Angles were measured in degrees.

The three variables measured in this study were,

Vertical position :

The perpendicular vertical distance between the center points (0) and (H').

+ sign means bracket is gingival to ideal horizontal reference line

- sign means bracket is occlusal to ideal horizontal reference line

Mesiodistal position:

The horizontal distance between the center point (0) and (V')

+ sign means bracket is more mesial to ideal vertical reference line

- sign means bracket is more distal to ideal vertical reference line

Angulation:

The angle between the (H) and (H') on the mesial side of the tooth.

+ sign means the H' is rotated anticlockwise to H.

- sign means the H' is rotated clockwise to H.

SONDHI RAPID SET RESIN A & B

TRANSBOND XT COMPOSITE AND PRIMER

ULTRASONIC CLEANER

MATERIALS FOR TRANSFER TRAY PREPARATION

MATERIALS FOR BONDING

TRANSFER TRAY WITH BRACKETS POSITIONED ON TEETH

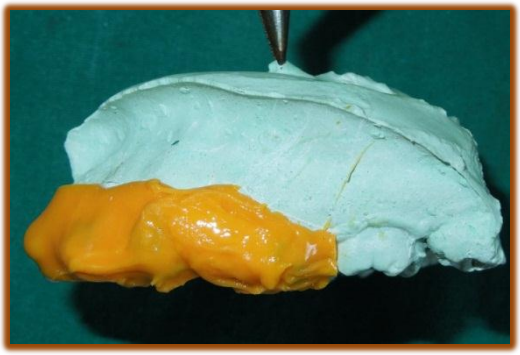
INDIRECTLY BONDED QUADRANT

COMPLETE BOND UP

BRACKETS POSITIONED ON MODEL - OCCLUSAL VIEW

BRACKETS POSITIONED ON MODEL - LATERAL VIEW

BRACKETS COVERED WITH LIGHT BODY C-SILICONE

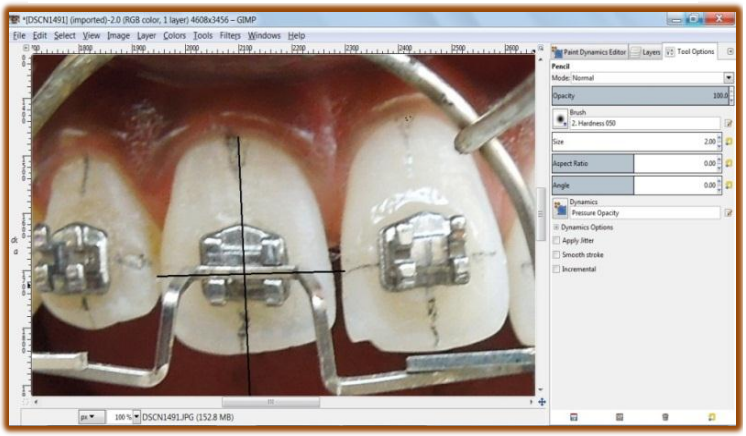


PUTTY C-SILICONE PLACED WITH PLASTIC TRAY

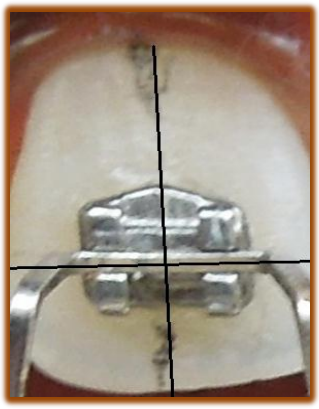
TRANSFER TRAY WITH BRACKETS LATERAL VIEW

TRANSFER TRAY TOP VIEW

EXPERIMENTAL REFERENCE LINES



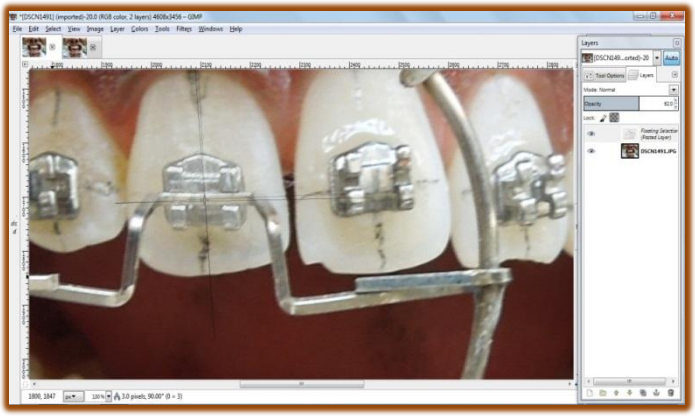
MAGNIFIED VIEW



MASKED BRACKET WITH IDEAL REFERENCE LINES

MAGNIFIED VIEW

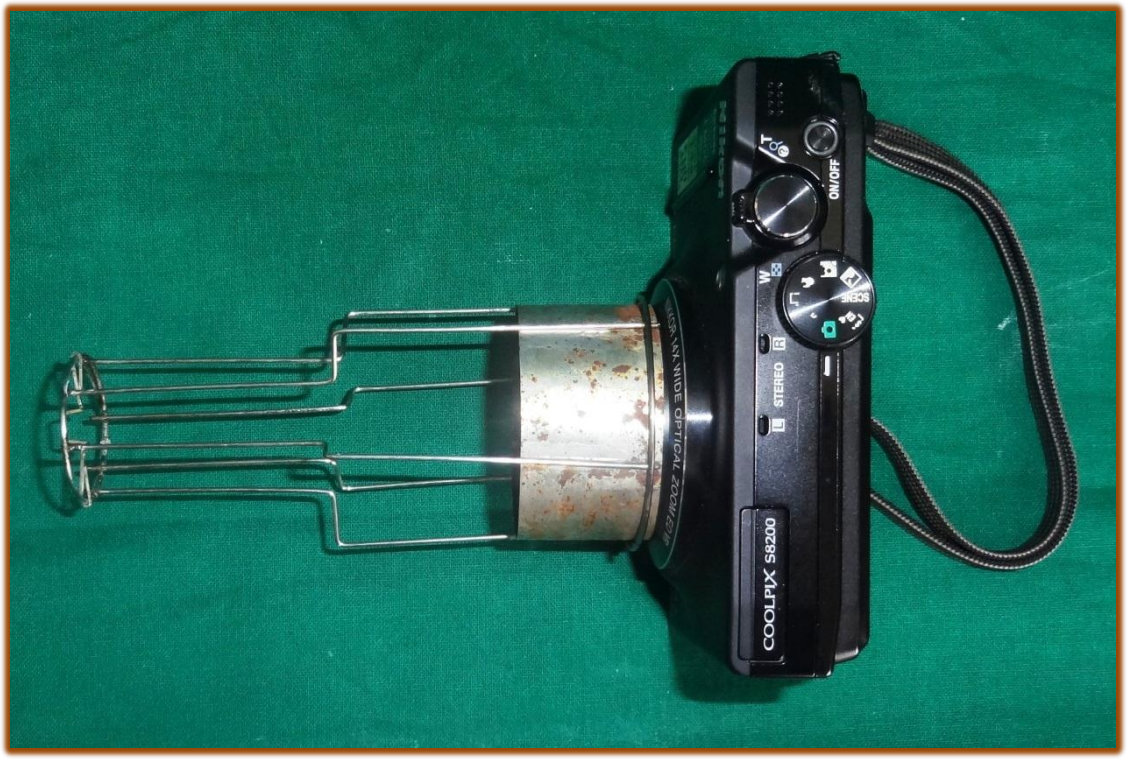
SUPERIMPOSING THE IDEAL & EXPERIMENTAL REFERENCE LINES



MAGNIFIED VIEW

CAMERA AND JIG

CAMERA WITH JIG



RESULTS

In this study the vertical position, mesiodistal position, angulations of brackets were compared between direct and indirect bracket placement. Both magnitude and direction of deviation in all three variables were noted. The direction of deviation was calculated as –ve, when the deviation was towards distal side, clockwise and incisal. The deviation was calculated as +ve, when deviation was towards mesial side, counterclockwise and gingival. All quadrants were separately compared between direct and indirect method for magnitude and direction of deviation. The data were analyzed using SPSS software by Independent sample T test.

Table 1 shows the mean magnitude of deviation of direct and indirect method for all three variables. Statistically significant difference was noticed in vertical and mesiodistal positioning of brackets, with lesser deviation in indirect method. The deviation in angulation of bracket was not statistically significant.

Table 2 shows the deviation of direction of direct and indirect method for all the three variables. There was a statistically significant difference in the direction of deviation between direct and indirect method for vertical positioning with more tendency for gingival placement of brackets in direct method.

Deviation in first quadrants

Table 3 shows that in first quadrant, the magnitude of vertical deviation between direct and indirect method was statistically significant with higher magnitude of deviation in

direct method. Both angle and mesiodistal position were not statistically significant.

Table 7 shows that statistically significant difference exists between direct and indirect method in vertical positioning towards gingival direction with more gingival placement in direct method.

Deviation in second quadrants

Table 4 shows that in second quadrant, the magnitude of mesiodistal deviation between direct and indirect method was statistically significant with higher magnitude of deviation in direct method.

Table 8 shows that there was no statistically significant difference between direct and indirect method in direction of placement in any of the three variables.

Deviation in third quadrants

Table 5 shows that in third quadrant, the magnitude of vertical position between direct and indirect method was statistically significant with higher magnitude of deviation in direct method.

Table 9 shows that statistically significant difference between direct and indirect method in vertical position towards gingival direction with more gingival placement in direct method and mesiodistal position towards distal direction with more distal direction in direct method.

Deviation in fourth quadrants

Table 6 shows that in fourth quadrant, the magnitude of mesiodistal deviation between

direct and indirect method was statistically significant with higher magnitude of difference in direct method.

Table 10 shows that there was no statistically significant difference between direct and indirect method in direction of placement in any of the three variables.

Deviation in tooth wise

Table 12 shows tooth wise mean magnitude of deviation for all three variables. It shows higher magnitude of deviation in vertical positioning for all teeth except for left upper lateral incisor where the magnitude of deviation was same for both direct and indirect method. The deviation in mesiodistal position was less compared to vertical positioning. The mean deviation in mesiodistal position was lesser in magnitude for all teeth except for upper right lateral incisor and lower left central and lateral incisor where direct bonding showed less deviation. The mean deviation in angulation was relatively less in indirect method.

Table 13 shows tooth wise mean direction of deviations between Direct and Indirect methods in +ve direction. In vertical positioning, the direct method shows more amount of gingival deviation of brackets. In mesiodistal positioning and angulation the difference between direct and indirect method in +ve direction are less.

Table 14 shows mean direction of deviations between Direct and Indirect methods in –ve direction. Comparing the table 13 and table 14 the vertical positioning magnitude is higher in gingival direction for direct and indirect method.

Table 1

Independent samples T-Test to compare the mean deviations between Direct and Indirect methods

	Method	N	Mean	Std. Dev	t-Value	P-Value
Vertical magnitude (mm)	Direct	180	0.080	0.051	3.580	<0.001
	Indirect	180	0.062	0.045		
Mesiodistal magnitude (mm)	Direct	180	0.055	0.044	2.757	0.006
	Indirect	180	0.043	0.041		
Angle magnitude (degree)	Direct	180	1.550	0.547	0.668	0.505
	Indirect	180	1.510	0.591		

Table 2

Independent samples T-Test to compare the mean deviations with direction between Direct and Indirect methods

	Method	N	Mean	Std. Dev	t-Value	P-Value
Vertical -ve (mm)	Direct	39	-0.069	0.056	0.543	0.589
	Indirect	30	-0.062	0.038		
Vertical +ve (mm)	Direct	135	0.087	0.047	3.203	0.002
	Indirect	134	0.070	0.043		
Mesiodistal -ve (mm)	Direct	39	-0.051	0.031	1.821	0.072
	Indirect	58	-0.041	0.023		
Mesiodistal +ve (mm)	Direct	122	0.066	0.045	0.246	0.806
	Indirect	84	0.064	0.045		
Angle -ve (degree)	Direct	81	-1.473	0.434	0.108	0.914
	Indirect	83	-1.481	0.444		
Angle +ve (degree)	Direct	95	1.682	0.534	0.326	0.745
	Indirect	90	1.655	0.566		

Independent samples T-Test to compare the mean deviations between Direct and Indirect methods in each quadrant

Table 3

First quadrant (deviation in magnitude)

	Method	N	Mean	Std. Dev	t-Value	P-Value
Vertical magnitude (mm)	Direct	45	0.097	0.051	3.469	0.001
	Indirect	45	0.065	0.034		
Mesiodistal magnitude (mm)	Direct	45	0.058	0.040	0.610	0.543
	Indirect	45	0.053	0.036		
Angle magnitude (degree)	Direct	45	1.697	0.549	0.665	0.508
	Indirect	45	1.618	0.580		

Table 4

Second quadrant (deviation in magnitude)

	Method	N	Mean	Std. Dev	t-Value	P-Value
Vertical magnitude (mm)	Direct	45	0.083	0.054	0.662	0.510
	Indirect	45	0.076	0.051		
Mesiodistal magnitude (mm)	Direct	45	0.070	0.047	3.010	0.003
	Indirect	45	0.043	0.037		
Angle magnitude (degree)	Direct	45	1.575	0.484	0.156	0.876
	Indirect	45	1.592	0.541		

Table 5

Third quadrant (deviation in magnitude)

	Method	N	Mean	Std. Dev	t-Value	P-Value
Vertical magnitude (mm)	Direct	42	0.068	0.044	2.730	0.008
	Indirect	48	0.044	0.039		
Mesiodistal magnitude (mm)	Direct	42	0.048	0.051	0.054	0.957
	Indirect	48	0.048	0.054		
Angle magnitude (degree)	Direct	42	1.432	0.686	0.492	0.624
	Indirect	48	1.360	0.689		

Table 6

Fourth quadrant (deviation in magnitude)

	Method	N	Mean	Std. Dev	t-Value	P-Value
Vertical magnitude (mm)	Direct	48	0.073	0.052	0.739	0.462
	Indirect	42	0.066	0.048		
Mesiodistal magnitude (mm)	Direct	48	0.046	0.035	2.712	0.008
	Indirect	42	0.027	0.031		
Angle magnitude (degree)	Direct	48	1.495	0.438	0.146	0.885
	Indirect	42	1.480	0.509		

Independent samples T-Test to compare the mean deviations with directions between Direct and Indirect methods in each quadrant

Table 7

First quadrant (deviation in direction)

	Method	N	Mean	Std. Dev	t-Value	P-Value
Vertical -ve (mm)	Direct	10	-0.098	0.065	2.275	0.041
	Indirect	7	-0.046	0.027		
Vertical +ve (mm)	Direct	35	0.097	0.048	2.716	0.008
	Indirect	37	0.070	0.033		
Mesiodistal -ve (mm)	Direct	7	-0.033	0.034	0.516	0.614
	Indirect	9	-0.040	0.021		
Mesiodistal +ve (mm)	Direct	38	0.063	0.040	0.320	0.750
	Indirect	31	0.066	0.033		
Angle -ve (degree)	Direct	24	-1.562	0.436	1.275	0.209
	Indirect	22	-1.397	0.438		
Angle +ve (degree)	Direct	20	1.944	0.479	0.213	0.832
	Indirect	22	1.911	0.497		

Table 8

Second quadrant (deviation in direction)

	Method	N	Mean	Std. Dev	t-Value	P-Value
Vertical -ve (mm)	Direct	6	-0.075	0.084	0.054	0.958
	Indirect	4	-0.073	0.045		
Vertical +ve (mm)	Direct	36	0.092	0.044	0.849	0.399
	Indirect	38	0.082	0.050		
Mesiodistal -ve (mm)	Direct	12	-0.048	0.027	1.387	0.175
	Indirect	22	-0.035	0.024		
Mesiodistal +ve (mm)	Direct	33	0.078	0.050	0.949	0.347
	Indirect	18	0.065	0.041		
Angle -ve (degree)	Direct	26	-1.484	0.388	0.714	0.478
	Indirect	27	-1.572	0.496		
Angle +ve (degree)	Direct	19	1.699	0.579	0.393	0.697
	Indirect	18	1.621	0.616		

Table 9

Third quadrant (deviation in direction)

	Method	N	Mean	Std. Dev	t-Value	P-Value
Vertical -ve (mm)	Direct	13	-0.066	0.023	0.499	0.622
	Indirect	15	-0.060	0.039		
Vertical +ve (mm)	Direct	27	0.073	0.049	2.298	0.026
	Indirect	26	0.047	0.035		
Mesiodistal -ve (mm)	Direct	9	-0.063	0.022	2.816	0.011
	Indirect	12	-0.038	0.020		
Mesiodistal +ve (mm)	Direct	20	0.073	0.056	0.271	0.788
	Indirect	27	0.068	0.061		
Angle -ve (degree)	Direct	12	-1.498	0.577	0.119	0.906
	Indirect	16	-1.521	0.443		
Angle +ve (degree)	Direct	27	1.561	0.588	0.277	0.783
	Indirect	27	1.517	0.591		

Table 10

Fourth quadrant (deviation in direction)

	Method	N	Mean	Std. Dev	t-Value	P-Value
Vertical -ve (mm)	Direct	10	-0.038	0.047	1.789	0.099
	Indirect	4	-0.088	0.045		
Vertical +ve (mm)	Direct	37	0.085	0.048	1.084	0.282
	Indirect	33	0.073	0.045		
Mesiodistal -ve (mm)	Direct	11	-0.056	0.038	0.287	0.777
	Indirect	15	-0.052	0.024		
Mesiodistal +ve (mm)	Direct	31	0.051	0.031	0.698	0.490
	Indirect	8	0.043	0.027		
Angle -ve (degree)	Direct	19	-1.331	0.385	0.637	0.528
	Indirect	18	-1.409	0.367		
Angle +ve (degree)	Direct	29	1.602	0.442	0.019	0.985
	Indirect	23	1.600	0.510		

Table 11

Proportions of values showing the direction of deviations

		Quadrant								Total	
		First		Second		Third		Fourth			
		N	%	N	%	N	%	N	%	N	%
Vertical Count	Equal	1	1.1	6	6.7	9	10.0	6	6.7	22	6.1
	Negative	17	18.9	10	11.1	28	31.1	14	15.6	69	19.2
	Positive	72	80.0	74	82.2	53	58.9	70	77.8	269	74.7
Mesiodistal Count	Equal	5	5.6	5	5.6	22	24.4	25	27.8	57	15.8
	Negative	16	17.8	34	37.8	21	23.3	26	28.9	97	26.9
	Positive	69	76.7	51	56.7	47	52.2	39	43.3	206	57.2
Angle Count	Equal	2	2.2	0	0.0	8	8.9	1	1.1	11	3.1
	Negative	46	51.1	53	58.9	28	31.1	37	41.1	164	45.6
	Positive	42	46.7	37	41.1	54	60.0	52	57.8	185	51.4
45Total		90	100.0	90	100.0	90	100.0	90	100.0	360	100.0

Table 12

The mean magnitude of deviations between Direct and Indirect methods

Tooth wise

Tooth no	Method											
	Direct						Indirect					
	Vertical (mm)		Mesiodistal (mm)		Angle (degree)		Vertical (mm)		Mesiodistal (mm)		Angle (degree)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
11	0.11	0.06	0.09	0.04	1.52	0.62	0.08	0.03	0.07	0.04	1.40	0.55
12	0.07	0.04	0.03	0.02	1.48	0.42	0.05	0.03	0.06	0.03	1.39	0.47
13	0.10	0.05	0.05	0.03	2.09	0.38	0.06	0.03	0.03	0.03	2.06	0.47
21	0.09	0.07	0.11	0.05	1.68	0.42	0.08	0.06	0.05	0.04	1.70	0.50
22	0.07	0.05	0.06	0.03	1.23	0.31	0.07	0.05	0.02	0.02	1.40	0.61
23	0.09	0.04	0.04	0.02	1.82	0.51	0.08	0.05	0.05	0.04	1.68	0.49
31	0.05	0.05	0.02	0.02	1.24	0.65	0.03	0.03	0.04	0.04	1.10	0.91
32	0.07	0.04	0.03	0.04	1.16	0.61	0.05	0.03	0.04	0.02	1.25	0.48
33	0.08	0.04	0.09	0.05	1.89	0.58	0.05	0.05	0.07	0.08	1.74	0.44
41	0.05	0.05	0.04	0.04	1.27	0.23	0.03	0.04	0.00	0.01	1.17	0.42
42	0.06	0.03	0.05	0.04	1.37	0.40	0.07	0.03	0.03	0.03	1.51	0.44
43	0.11	0.05	0.04	0.03	1.85	0.43	0.10	0.05	0.05	0.03	1.77	0.51

Table 13

The mean direction of deviations between Direct and Indirect methods

Tooth wise

+ve direction

Tooth no	Method											
	Direct						Indirect					
	Vertical +ve (mm)		Mesiodistal +ve (mm)		Angle +ve (degree)		Vertical +ve (mm)		Mesiodistal +ve (mm)		Angle +ve (degree)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
11	0.13	0.05	0.10	0.04	1.99	0.45	0.09	0.03	0.08	0.03	1.89	0.38
12	0.08	0.04	0.03	0.02	1.34	0.15	0.06	0.03	0.07	0.03	1.28	0.22
13	0.09	0.05	0.05	0.01	2.08	0.45	0.06	0.03	0.04	0.03	2.05	0.48
21	0.10	0.05	0.14	0.03	1.76	0.62	0.09	0.05	0.09	0.01	2.02	0.95
22	0.08	0.05	0.06	0.03	1.24	0.11	0.07	0.05	0.03	0.02	1.49	0.82
23	0.10	0.04	0.04	0.03	1.91	0.61	0.08	0.05	0.07	0.06	1.62	0.45
31	0.06	0.05	0.02	.	1.32	0.70	0.05	0.03	0.06	0.03	1.48	0.87
32	0.07	0.05	0.03	0.01	1.43	0.47	0.05	0.02	0.04	0.02	1.37	0.46
33	0.10	0.04	0.09	0.05	1.79	0.55	0.05	0.05	0.12	0.09	1.67	0.43
41	0.06	0.06	0.04	0.04	1.30	0.19	0.04	0.04	0.02	.	1.23	0.26
42	0.07	0.02	0.05	0.03	1.65	0.52	0.07	0.03	0.05	0.02	2.11	0.02
43	0.11	0.05	0.07	0.02	1.86	0.44	0.10	0.05	0.04	0.03	1.72	0.54

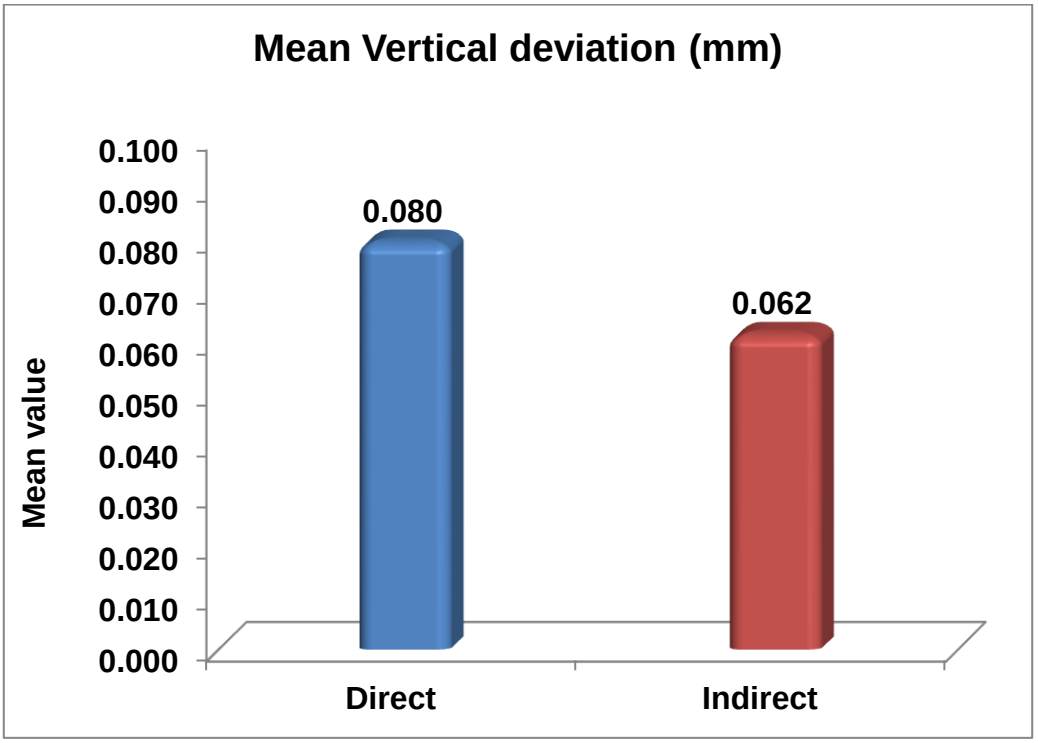
Table 14

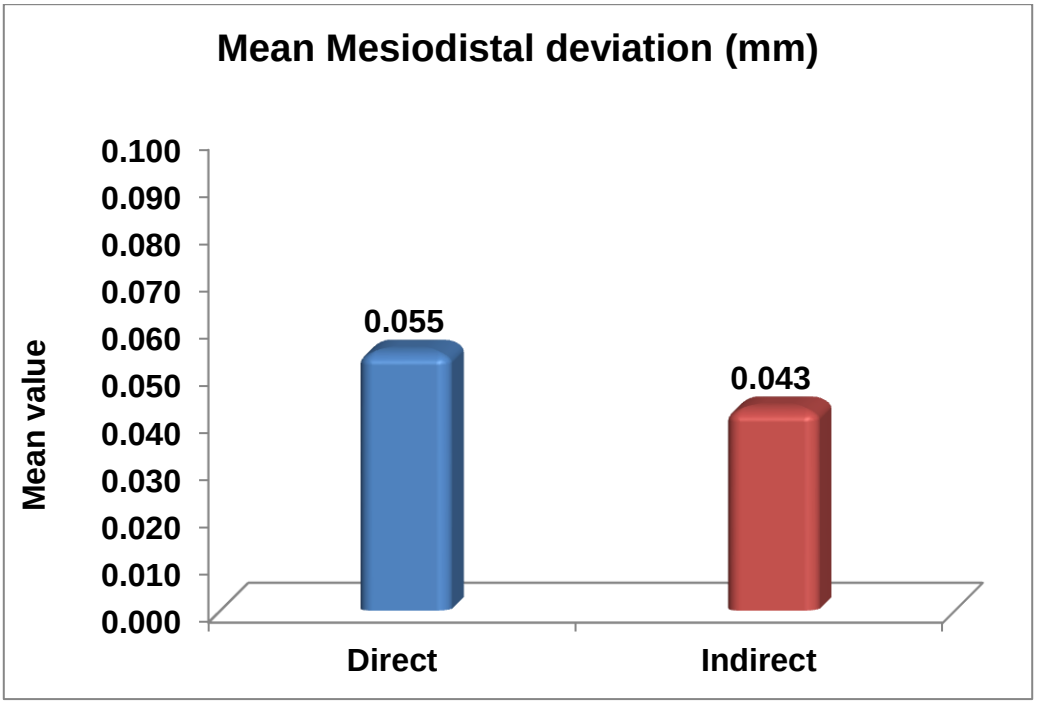
The mean direction of deviations between Direct and Indirect methods

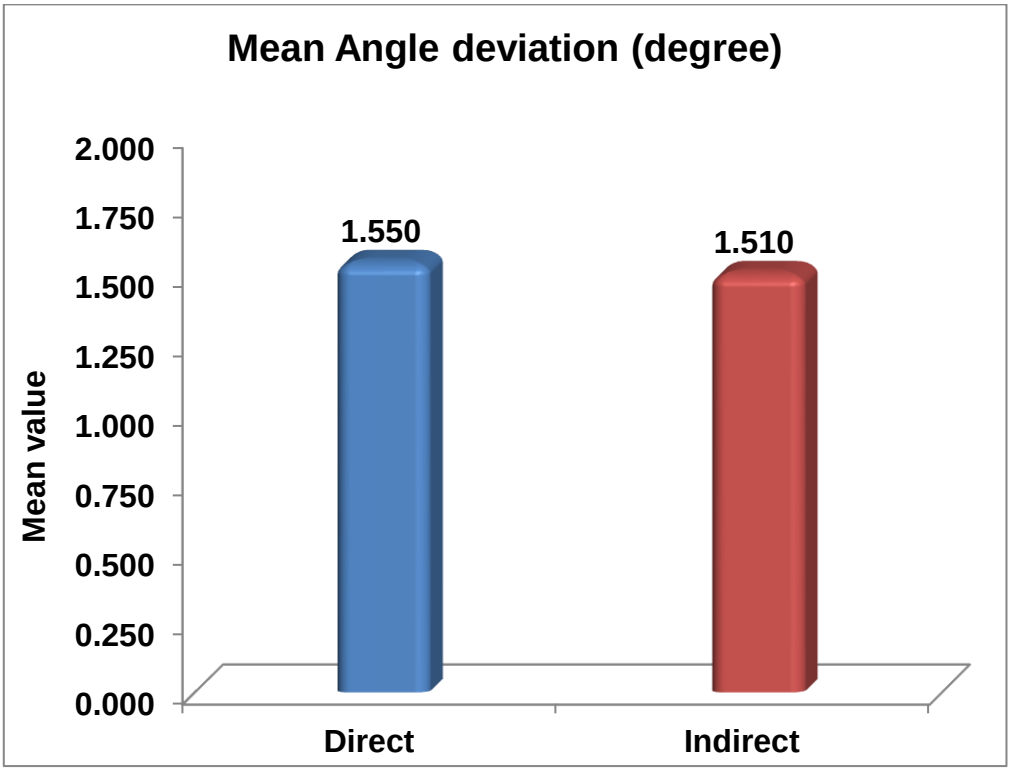
Tooth wise

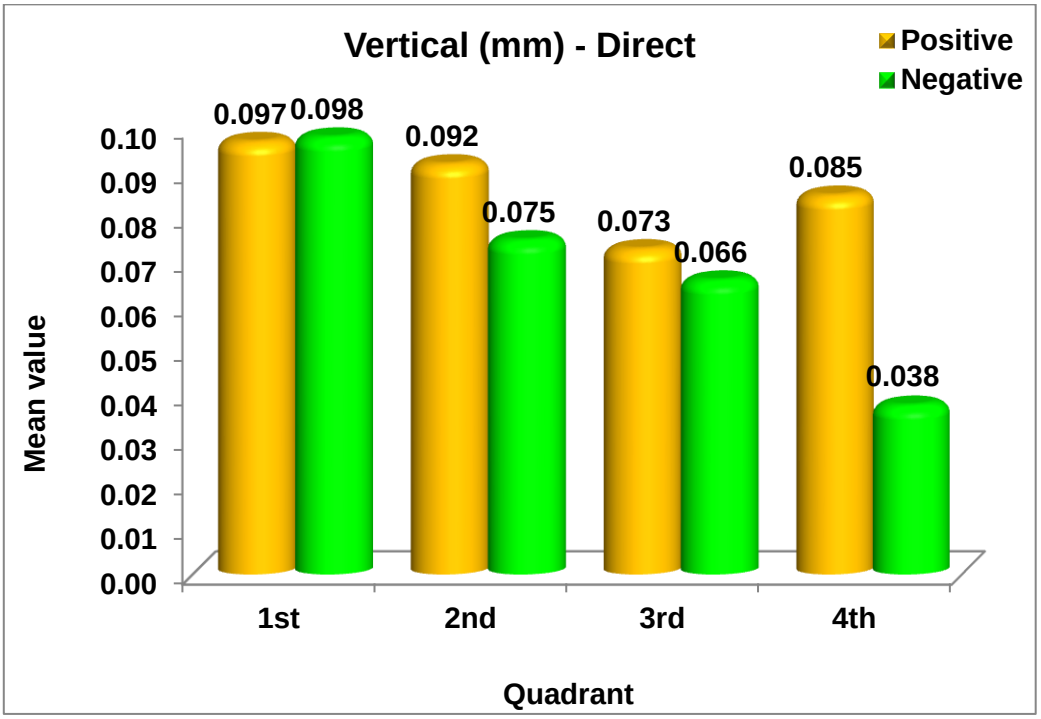
-ve direction

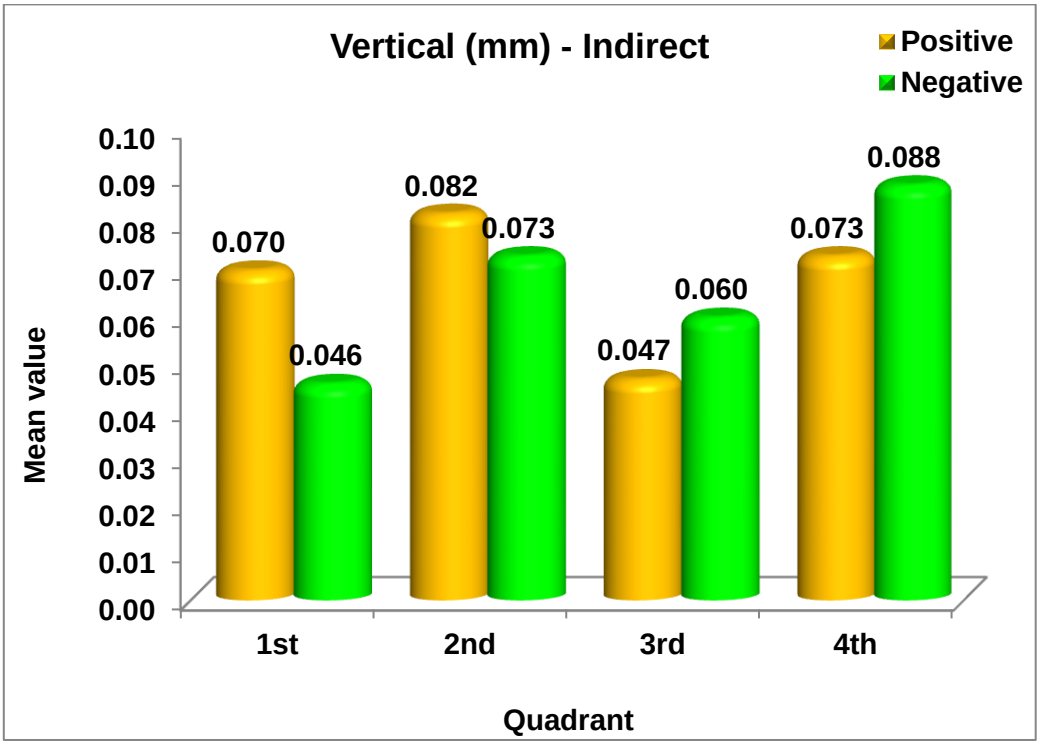
Tooth no	Method											
	Direct						Indirect					
	Vertical -ve (mm)		Mesiodistal -ve (mm)		Angle -ve (degree)		Vertical -ve (mm)		Mesiodistal -ve (mm)		Angle -ve (degree)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
11	-0.09	0.07	-0.02	.	-1.35	0.24	-0.06	0.02	-0.05	.	-1.29	0.23
12	-0.02	.	.	.	-1.52	0.46	-0.02	0.00	-0.04	0.03	-1.42	0.52
13	-0.13	0.04	-0.04	0.04	-2.12	0.02	-0.08	.	-0.03	0.02	-2.14	.
21	-0.09	0.12	-0.07	0.03	-1.65	0.36	.	.	-0.03	0.03	-1.65	0.44
22	-0.05	.	.	.	-1.23	0.38	-0.08	0.04	-0.03	0.03	-1.34	0.47
23	-0.07	0.06	-0.03	0.02	-1.63	0.12	-0.07	0.06	-0.04	0.02	-1.79	0.62
31	-0.07	0.02	-0.05	0.00	-1.36	0.43	-0.05	0.00	-0.05	0.00	-1.43	0.48
32	-0.07	0.03	-0.09	0.02	-1.21	0.15	-0.06	0.05	-0.04	0.03	-1.27	0.16
33	-0.07	0.03	.	.	-2.49	0.54	-0.07	0.04	-0.03	0.02	-1.84	0.46
41	-0.05	0.06	-0.05	.	-1.19	0.34	-0.02	.	.	.	-1.31	0.28
42	-0.02	0.00	-0.07	0.05	-1.27	0.33	-0.11	.	-0.05	0.00	-1.34	0.33
43	.	.	-0.04	0.02	-1.77	0.48	-0.11	0.00	-0.05	0.03	-2.04	0.15

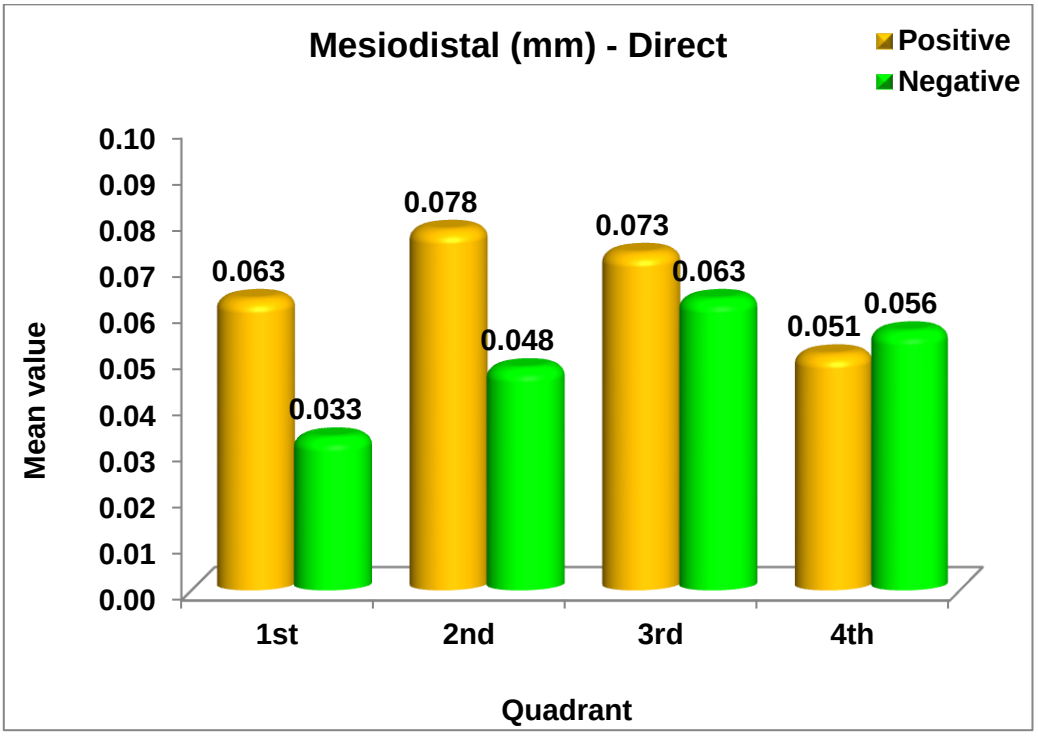

Mean Vertical deviation (mm)
Mean value
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
0.080
0.062
Direct
Indirect

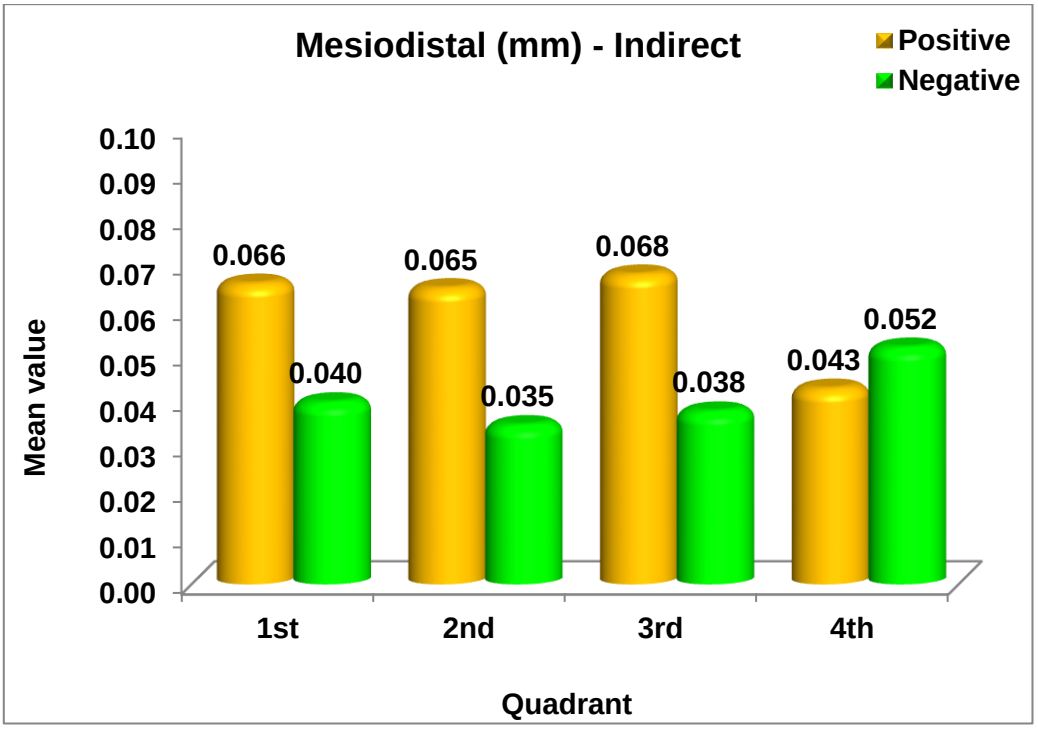

Mean Mesiodistal deviation (mm)
Mean value
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
0.055
0.043
Direct
Indirect

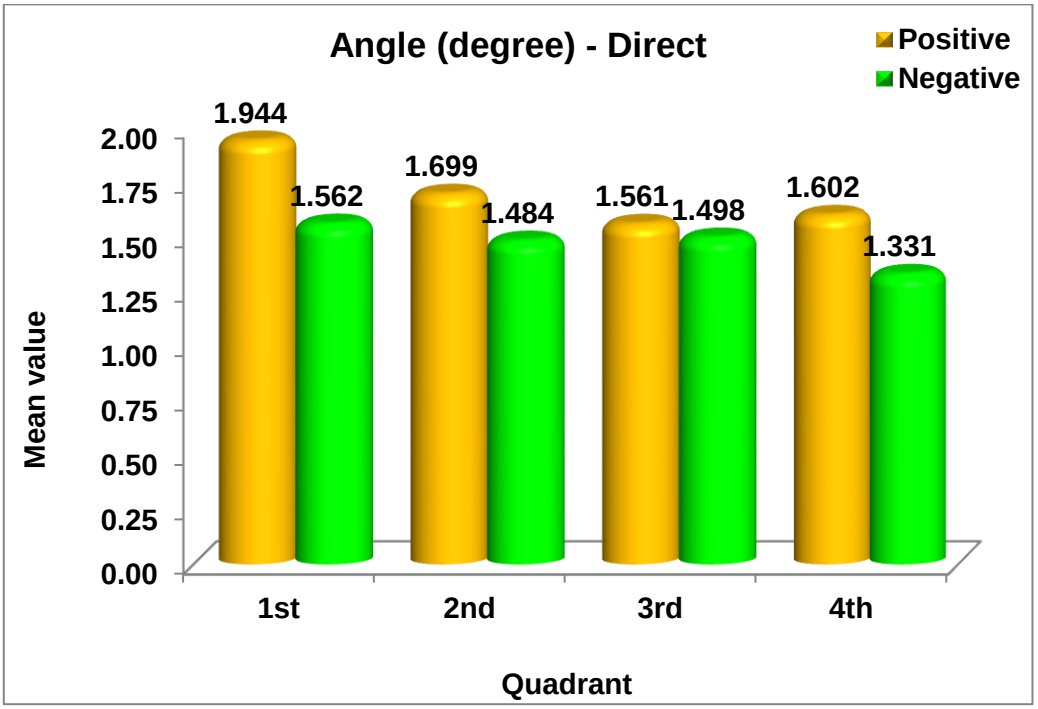

Mean Angle deviation (degree)
Mean value
2.000
1.750
1.500
1.250
1.000
0.750
0.500
0.250
0.000
1.550
1.510
Direct
Indirect

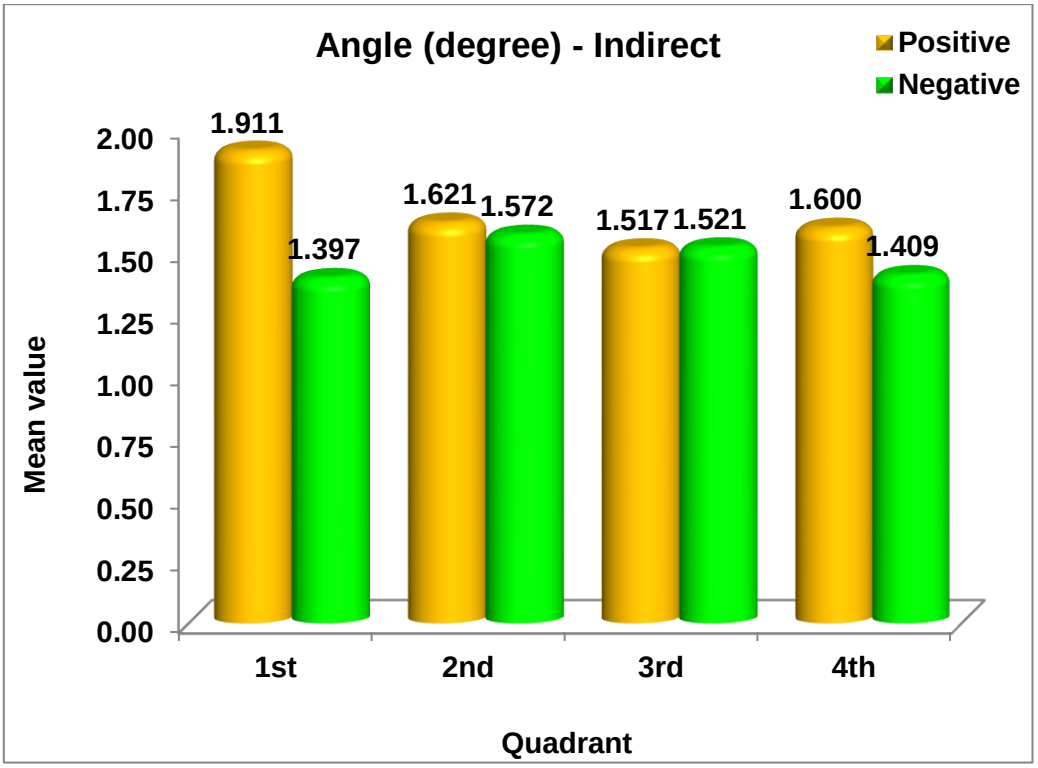

Vertical (mm) - Direct
Positive
Negative
Mean value
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.097
0.098
0.092
0.075
0.073
0.066
0.085
0.038
1st
2nd
3rd
4th
Quadrant


Vertical (mm) - Indirect
Positive
Negative
Mean value
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.070
0.046
0.082
0.073
0.047
0.060
0.073
0.088
1st
2nd
3rd
4th
Quadrant


Mesiodistal (mm) - Direct
Positive
Negative
Mean value
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.063
0.033
0.078
0.048
0.073
0.063
0.051
0.056
1st
2nd
3rd
4th
Quadrant


Mesiodistal (mm) - Indirect
Positive
Negative
Mean value
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.066
0.040
0.065
0.035
0.068
0.038
0.043
0.052
1st
2nd
3rd
4th
Quadrant


Angle (degree) - Direct
Positive
Negative
1.944
1.562
1.699
1.484
1.561
1.498
1.602
1.331
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Mean value
1st
2nd
3rd
4th
Quadrant


Angle (degree) - Indirect
Positive
Negative
1.911
1.397
1.621
1.572
1.517
1.521
1.600
1.409
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Mean value
1st
2nd
3rd
4th
Quadrant

DISCUSSION

Fixed orthodontic appliances from their inception have been refined to the present state. Initial fixed orthodontic appliances had their brackets welded on to metal bands and cemented over teeth surface. With the introduction of acid etching technique by Michel Buonocore[36] in 1955, the possibility of direct placement of brackets on the enamel surface evolved. In 1965 George Newman[22] described the technique to directly place the brackets on tooth's surface with 40% phosphoric acid for enamel conditioning and polyamide cured epoxy resin.

Direct bonding of brackets on to a tooth surface emerged to claim significant advantages over banding the brackets on teeth like, (1) less consumption of chair side time, reducing patient's visits for bracket placement, (2) easy clean up, reducing risk of enamel demineralisation, (3) more comfort for the patients, increasing patient compliance (4) lesser consumption of operator's energy, increasing clinician's efficiency (5) improved precision of bracket placement on teeth surface. These advantages made the direct bonding of brackets popular.

In 1972, Silverman and Cohen[19] described a method of universal direct bonding system from which the indirect bonding technique evolved. This technique was further modified by Royce G. Thomas[49] in the year 1979 to form custom composite base for the brackets. In this study, this preformed

composite coating of bracket bases was done with light cure composite. The advantages of this pre coating are, (1) light cure composite allows sufficient time for the operator to place the brackets in precise position before curing (2) consistency of bracket placement and, (3) differences in bucco lingual thickness of the teeth can be compensated[34].

From introduction of this indirect bonding technique several modifications have been introduced, in terms of materials used for positioning brackets on working models, transfer tray fabrication and bonding adhesives. The advantages of indirect bonding technique claimed over direct bonding are, (1) more accurate bracket placement (2) less chair time (3) better ergonomics for operator (4) reduced need for direct visualization during bonding. The disadvantages quoted are, (1) higher laboratory cost (2) operator sensitive (3) difficulty in removal of excess bonding adhesive from teeth surface (5) bracket bases not entirely filled with bonding adhesives and, (6) increased thickness of adhesive on bracket base. Though it was logical to say that the bracket placement can be more precise on the handheld, completely accessible, dry models, the studies to strengthen the claim of high precision in bracket positioning are very few.

Bon chan koo et al[13] conducted a study on mannequins to compare the accuracy between direct and indirect bonding methods and concluded that indirect bonding was better in vertical bracket placement but mesiodistal and angulation were not significantly different. Hodge et al[55] conducted a similar

study in clinical situation and concluded that the mean error in vertical plane was more than mesiodistal plane and mean bracket error was similar to both techniques. Thus contradicting the previous view regarding accuracy of bracket positioning. Bjorn U. Zacrisson et al[14] opined that for clinical purposes, no obvious difference could be appreciated in bracket placement between the indirect and direct techniques, with the possible exception of few posterior teeth in difficult positions and that with some experience, it might be possible to position the brackets precisely even with direct bonding approach.

In this study, Sondhi rapid set[4], the resin developed by Anoop sondhi in 1999 was used to position the brackets on teeth surface. The viscosity of the resin was relatively less than any other conventional bonding resin. This property is said to fill the micro defects in the preformed composite bracket bases used in this study. Though the viscosity of the resin was reduced, Arndt klocke et al[8] showed that the shear bond strength of this resin with pre coated bracket base was comparable with any other resin used for indirect bonding technique. The resin is chemically cured hence avoids the necessity of clear transfer tray for light permission in case of light cure resin. The main advantage of this resin is its quick setting time of 30 seconds which allows removing the transfer tray in 30 seconds. The dual layer transfer tray was prepared, which provided rigid outer tray to ease the placement of tray without distortion and flexible inner tray to ease the removal of transfer tray from the teeth after bond up.

The magnification of image in the photograph were standardized to be same throughout the study with a custom fabricated jig that was attached to the camera. Bon chan koo et al[13] have examined the accuracy by superimposing the hand traced images on acetate paper. In our study to minimise human error, software was used for superimposition and measuring the accuracy of bracket placement. Hodge et al[55] have traced the outline of crown and bracket tie wings manually. Wendel et al[10] conducted an in vitro study and used a new transfer device, Aptus bonding device to transfer the brackets. They used three dimensional measurements on the working and plaster models using 3D laser scan to measure the accuracy of bracket positioning.

In this study, we have located the magnitude and direction of error separately without combining the +ve and –ve values between direct and indirect bonding in tooth and quadrant wise.

Vertical positioning of brackets influences the final vertical positioning of teeth; horizontal position influences the rotational tendency of teeth; angulation influences the mesiodistal tip of teeth. So to achieve the desired final position of teeth, these three positions of brackets must be precise. In this study the precise placement of brackets between direct and indirect techniques was examined by comparing the three variables namely, vertical positioning, mesio-distal positioning and angulations of brackets.

The results in this study reveal significant magnitude of deviation in vertical and mesiodistal positioning of bracket between direct and indirect method

with greater magnitude of deviation in vertical positioning. Though the magnitude of deviation for vertical position is higher for both direct and indirect method than the other two variables, the direct method shows higher magnitude of deviation. This may be due to the relatively long inciso-gingival plane of tooth. The mesiodistal deviations were relatively less for all samples. This may be due to the smaller surface area measured from two-dimensional picture than the actual value measured on a three-dimensional curved tooth surface.

In angulation, though the deviation was not significant between direct and indirect method, wider range of deviation was found compared to vertical and mesiodistal position in direct and indirect methods. For example, the angulation deviation in left lower central incisor in direct method was 1.24º with standard deviation of 0.65º, in that same case the deviation in vertical positioning was 0.05 mm with standard deviation of 0.05 mm. This shows that the long axis is difficult to assess accurately in clinical situation. Another possibility for this higher range of deviation is that, as the bracket dimensions are standard, positioning the brackets considering both external contour of tooth and visualizing the long axis of crown produces higher discrepancy in angulation. Furthermore, Andrews[3] found that operators were poor at judging angular measurements.

Considering the direction, in mesiodistal position and angulation there was no significant difference between direct and indirect method. Deviation towards

mesial or distal in mesiodistal plane and clockwise or counter clockwise rotation in angulation were of same level for both direct and indirect method.

In vertical position there were more tendencies to place the bracket towards gingival direction in direct method. In Roth prescription of bracket positioning[61], vertical position of premolar determines the vertical position on other teeth, where the bracket positioning requires them to be placed as per the measured height and not in the exact centre of tooth. The tendency to position the bracket towards the centre of tooth by the operator could have caused more deviation toward the gingival direction.

On second quadrant the deviation in mesiodistal positioning between direct and indirect bonding was statistically significant with relatively more mesial positioning of brackets in direct method. Though lips and cheek are retracted to provide better visibility and sufficient access to place the brackets in the exact place, a right handed operator may find some difficulty to visualize the entire mesiodistal surface of teeth on the upper left quadrants, which may make the operator to err towards more mesial positioning of brackets. As the mesiodistal surface of anterior teeth in lower quadrants are relatively more clearly visible than the upper anterior dentition, mesiodistal positioning in third quadrant was not statistically significant between direct and indirect method.

Aguirre et al[1] and Balut et al[9] did not consider mesio-distal errors in their study, although clinically such errors can cause rotational irregularities. Bon

chan koo et al[13] and Hodge et al[55] compared the two techniques with magnitude and direction. But they obtained the mean values of both +ve and – ve direction together, which can mask the actual discrepancy of bracket positioning. Hodge et al[55] found more gingival placement of brackets in vertical position and higher mesio distal error than angulation. Nir shpack et al[41] assessed the rotational deviation and torque error between direct and indirect bonding in both labial and lingual appliances and found that indirect bonding was more accurate in both the appliance techniques. Wendel et al[10] stated that the bracket deviations in X, Y, Z axis are too small in indirect bonding.

Though maximum efforts were taken to standardize all the procedures in this study with precision being the main concern, human error which is innate to every human is unavoidable and could have happened in any stage of this study. All the parameters were measured by single operator in this study. Further studies are needed to compare the inter operator variation in the bonding techniques.

SUMMARY AND CONCLUSION

As both direct and indirect bonding techniques have comparable advantages and disadvantages, this study was aimed at comparing the accuracy of bracket positioning following direct and indirect bonding techniques and identifying the better of the two techniques. 30 patients received direct bonding in two of their arch quadrants and indirect bonding in the other two arch quadrants. Accuracy in horizontal plane, vertical plane and angulations of each bracket was checked with reference to an ideal bracket position with help of computer software. The data was statistically analysed and the following conclusions were arrived at.

CONCLUSIONS

1. The linear and angular measurements evaluated in this study showed that neither direct nor indirect were 100% accurate in bracket positioning.
2. Indirect bonding technique provided better placement of brackets in vertical and mesiodistal positioning.
3. In vertical positioning, the tendency to position brackets in gingival direction in both direct and indirect bonding was more.
4. Though angular deviation existed in both direct and indirect bonding techniques, neither of them proved to be better than the other.

5. On summation, the precision in bracket placement claimed for the indirect method is validated in this study. The indirect bonding procedure could provide efficient bracket placement in significantly lesser chair side time, which overweighs the cost involved in the laboratory procedure.

BIBLIOGRAPHY

1. **Aguirre M, King G, Waldron J.** Assessment of bracket placement and bond strength when comparing direct bonding to indirect bonding techniques. Am J Orthod 1982; 82: 269–76.
2. **Anas Al Najjar, Zackary Faber, Richard Faber** "Reverse" Indirect Bonding: A Protocol for Temporary Debonding. Journal of Clinical Orthodontics 2011; 45:610-613.
3. **Andrews LF** The straight-wire appliance. Br J Orthod 1979; **6**: 125–43.
4. **Anoop Sondhi** Efficient and effective indirect bonding. American Journal of Orthod Dentofacial Orthop 1999; 115: 352-359.
5. **Arndt Klocke, Drazen Tadic, Farhad Vaziric, Ba¨rbel Kahl-Nieke** Custom Base Preaging in Indirect Bonding. Angle Orthodontist 2004; 74: 106–111.
6. **Arndt Klocke, Jianmin, Farhad Vaziri, Ba¨rbel Kahl-Nieke, Ulrich Bismayer** Effect of Time on Bond Strength in Indirect Bonding. Angle Orthodontist 2004; 74: 245–250.
7. **Arndt Klocke, Jianmin Shi,Ba¨rbel Kahl-Nieke, Ulrich Bismayer** In Vitro Investigation of Indirect Bonding with a Hydrophilic Primer. Angle Orthod 2003; 73:445–450.

8. **Arndt Klocke, Jianmin, Ba¨rbel Kahl-Nieke, Ulrich Bismayer** Bond Strength with Custom Base Indirect Bonding Techniques. Angle Orthod 2003; 73:176–180.
9. **Balut N, Klapper L, Sandrik J, Bowman D.** Variations in bracket placement in the preadjusted appliance. Am J Orthod Dentofac Orthop 1992; 102: 62–7.
10. **B. Wendl , H. Droschl and P. Muchitsch** Indirect bonding — a new transfer method. European Journal of Orthodontics 2008; 30: 100–107.
11. **Barry D. Hoffman** Indirect Bonding with a Diagnostic Setup. Journal of Clinical Orthodontics 1988; 22:509-511.
12. **Birte Melsen, Piero Biaggini** The Ray Set: A New Technique for Precise Indirect Bonding. Journal of Clinical Orthodontics 2002; 36:648-654.
13. **Bon Chan Koo, Chun-Hsi Chung, Robert L. Vanarsdall** Comparison of the accuracy of bracket placement between direct and indirect bonding techniques. Am J Orthod Dentofacial Orthop 1999;116:346-51.
14. **Bjorn U. Zachrisson and Bjiirn Brobakken** Clinical comparison of direct versus indirect bonding with different bracket types and adhesives. Am Journal Of Orthod 1978; 74:62-78.
15. **Brandon James Linn, David W. Berzins, Virendra B. Dhuru, Thomas Gerard Bradley** A Comparison of Bond Strength

Between Direct- and Indirect-bonding Methods. Angle Orthod 2006; 76:289–294.

16. **Domenico Dalessandri, Michela Dalessandri, Stefano Bonetti, Luca Visconti, Corrado Paganelli** Effectiveness of an indirect bonding technique in reducing plaque accumulation around braces. Angle Orthod. 0000; 00:000–000.
17. **Duncan W. Higgins** Indirect Bonding with Light-Cured Adhesive and a Hybrid Transfer Tray. Semin Orthod 2007; 13:64-68.
18. **Eliades T, Gioka C, Papaconstantinou S, et al** Premolar bracket position revised: proximal and occlusal contacts assessment. World J Orthod 6:149-155, 2005.
19. **Elliott Silverman, Morton Cohen, Anthony A. Gianelly, Victor Dietz** A universal direct bonding system for both metal and plastic brackets. Am Journal Of Orthod Dentofac Orthop 1972;62:236-244.
20. **Fabio Ciuffolo, Ettore Epifania, Gionni Duranti, Valentina De Luca, Daniele Raviglia, Silvia Rezza, Felice Festa** Rapid prototyping: A new method of preparing trays for indirect bonding. Am J Orthod Dentofacial Orthop 2006; 129:75-77.
21. **Farhad Moshiri, Michael D. Hayward** Improved Laboratory Procedure for Indirect Bonding. Journal Of Clinical Orthodontics 1979;13:472-473.

22. **George V.Newman** Epoxy adhesives for orthodontic attachments:progress report. Am Journal Of Orthod And Dentofacial Orthopaedics 1965;51:901-912.
23. **Gia K. Yi, William J. Dunn and Louis J. Taloumis** Shear bond strength comparison between direct and indirect bonded orthodontic brackets. Am J Orthod Dentofacial Orthop 2003;124:577-81.
24. **Jacob Daub, David W. Berzins, Brandon James Linn, Thomas Gerard Bradley** Bond Strength of Direct and Indirect Bonded Brackets After Thermocycling. Angle Orthod 2006;76:295–300.
25. **Jim W.Milne, George F. Andreasen,Jane R. Jakobsen** bonding strength comparison:A simplified indirect technique versus direct placement of brackets Am J Orthod Dentofac Orthop 1989;96:8-15.
26. **Jing yi shiau et al** bond strength of aged composites found in brackets placed by indirect technique. Angle Orthod 1993;63:213-220.
27. **John T. Kalange** Ideal Appliance Placement with APC Brackets and Indirect Bonding. Journal Of Clinical Orthodontics1999;33: 517-526 .
28. **Julio P. Cal-Neto, Simone Castro, Pollyana Marques Moura, Daniel Ribeiro, Jose´ Augusto M. Miguel** Influence of enamel sandblasting prior to etching on shear bond strength of indirectly bonded lingual appliances. Angle Orthod.2011;81:149–152.

29. **Klaus D. Gerkha, Peter M. Schopf** Controlled Etching System for Direct and Indirect Bonding. Journal of Clinical Orthodontics 1987;21:842-846.
30. **Kenneth H. Fried, George V. Newman** Indirect Bonding with a No-Mix Adhesive. Journal Of Clinical Orthodontics 1983;17:414-419.
31. **Larry W. White** A New and Improved Indirect Bonding Technique. Journal Of Clinical Orthodontics 1999;33:17-23.
32. **Leonordo Foresti, Orlando Chevitarese** Sealent And Resin Viscosity And Their Influence On Resin Tags. Angle Orthd 1994;64:383-388.
33. **Mauro Cozzani, Anna Menini, Andrea Bertelli** Etching Masks for Precise Indirect Bonding. Journal Of Clinical Orthodontics 2010;44: 326-330.
34. **McLaughlin, Bennet, Trevesi** systemized orthodontic treatment mechanics. Mosby international Ltd, 2001.
35. **Michael A. Thompson, James L. Drummond and Ellen A. BeGole Bond** Strength analysis of custom base variables in indirect bonding techniques. Am J Orthod Dentofacial Orthop 2008; 133: 9.e15-9.e20.
36. **Michel Buonocore** A Simple Method Of Increasing The Adhesion Of Acrylic Filling Materials To Enamel Surfaces. Journal Of Dental Research 1955;34:849-853.

37. **Michael D. Simmons** Improved Laboratory Procedure for Indirect Bonding of Attachments. Journal Of Clinical Orthodontics 1978;12:300-302.
38. **Michael J.F. Read, Andrew I. Pearson** A Method for Light-Cured Indirect Bonding. Journal of Clinical Orthod. 1998;32:502-503.
39. **M. J. F. Read and K. D. O'Brien** A clinical trial of an indirect bonding technique with a visible light-cured adhesive .Am J Orthoo Dentofac Orthop 1990;98:259-62.
40. **N.E.A. Myrberg, C.F. Warner** Indirect Bonding Technique. Journal of Clinical Orthod 1982;16:269-272.
41. **Nir Shpack, Silvia Geron, Ioannis Floris, Moshe Davidovitch, Tamar Brosh, Alexander Dan Vardimon** Bracket Placement in Lingual vs Labial Systems and Direct vs Indirect Bonding. Angle Orthodontist 2007;77:509-517.
42. **O¨mu¨ r Polat, Tancan Uysal, Ali Ihya Karaman** Effects of a Chlorhexidine Varnish on Shear Bond Strength in Indirect Bonding. Angle Orthod 2005;75:1036–1040.
43. **Omur Polat, Ali Ihya Karaman, Tamer Buyukyilmaz** In Vitro Evaluation of Shear Bond Strengths and In Vivo Analysis of Bond Survival of Indirect-Bonding Resins. Angle Orthod 2004;74:405–409.

44. **Peter G. Milesa; Robert J. Weyant** A Comparison of Two Indirect Bonding Adhesives. Angle Orthod 2005;75:1019–1023.
45. **Philip P. Soo, Brian M. Green and Anoop Sondhi** Effects of oxygen inhibition in indirect bonding with a hydrophilic adhesive. Am J Orthod Dentofacial Orthop 2009;135:214-21.
46. **Rafael Bowen** Dental filling material comprising vinyl silane treated fused silica and a binder consisting of the reaction product of Bis Phenol And Glycidyl Acrylate. United states patent office; patented November 1962.
47. **Richard A. Hocevar and Howard F. Vincent** Indirect versus direct bonding: Bond strength and failure location . Am J Orthod Dentofac Orthop 1988;94:367-71.
48. **Rohit Sachdeva et al** SureSmile: A Report of Clinical Findings. Journal Of Clinical Orthodontics 2005;39:297-314.
49. **Royce G. Thomas** Indirect Bonding: Simplicity in Action. Journal of Clinical Orthod. 1979;13:93-106.
50. **Ronald B. Cooper, Nile A. Sorenson** Indirect Bonding with Adhesive Precoated Brackets. Journal Of Clinical Orthodontics 1993;27:164-167.
51. **Ronald B. Cooper, Marguerite Goss, Warren Hamula** Direct Bonding with Light-Cured Adhesive Precoated Brackets. Journal Of Clinical Orthodontics 1992;26:477-479.

52. **Samir E. Bishara, Adam W. Ostby, John F. Laffoon, John J. Warren** The Effect of Modifying the Self-etchant Bonding Protocol on the Shear Bond Strength of Orthodontic Brackets. Angle Orthodontist 2007;77:504-508.
53. **Stephen J. Reichheld, Robert A. Ritucci, Anthony A. Gianelly** An Indirect Bonding Technique. Journal of Clinical Orthod.1990;24:21-24.
54. **Seung-Min Lim, Ryoon-Ki Hong, Je-Young Park** A New Indirect Bonding Technique for Lingual Retainers. Journal Of Clinical Orthodontics 2004;38:652-655.
55. **T. M. Hodge, A. A. Dhopatkar and W. P. Rock** A randomized clinical trial comparing the accuracy of direct versus indirect bracket placement. Journal of Orthodontics;31, 2004, 132–137.
56. **Takeshi Muguruma, Yoshitaka Yasuda, Masahiro Iijima, Naohisa Kohda, Itaru Mizoguchi** Force and amount of resin composite paste used indirect and indirect bonding. Angle Orthod. 2010;80:1089–1094.
57. **Tancan Uysal, Zafer Sari, Abdullah Demir** Are the Flowable Composites Suitable for Orthodontic Bracket Bonding?. Angle Orthod 2004;74:697–702.
58. **Theodore Eliades, George Eliades, William A. Brantley, William M. Johnston** Polymerization efficiency of chemically

cured and visible light-cured orthodontic adhesives: Degree of cure. Am J Orthod Dentofac Orthop 1995;108:294-301 .

59. **Thomas D. Creekmore, Larry W. White** JCO INTERVIEWS Thomas D. Creekmore, DDS, on Treatment Mechanics. Journal Of Clinical Orthodontics 1996;30:631-638.
60. **Thomas E. Perkowski** Indirect Technique. Journal Of Clinical Orthodontics 1970;4:677-684.
61. **Thomas M. Graber, Brained F. Swain** Orthodontics: Current principals and techniques. The C.V.Mosby company, 679-680.
62. **Thiagarajah et al** A clinical comparison of bracket bond failures in association with direct and indirect bonding. Journal of orthodontics 2006; 33: 198-204.
63. **William J. Redmond, John Redmond and W. Ron Redmond** The OrthoCAD bracket placement solution. Am J Orthod Dentofacial Orthop 2004;125:645-646.
64. **Wolfgang carstensen** Clinical effects of reduction of acid concentration on direct bonding of brackets. Angle Orthodontist 1993;63:221-224.

INFORMATION SHEET

We are conducting a study on **"Accuracy of bracket positioning in direct and indirect bonding techniques".**

The purpose of this study is to compare the accuracy of bracket positioning in direct and indirect bonding techniques.

The privacy of the subjects in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.

The results of the special study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

Signature of investigator Signature of parent/ guardian

Date:

INFORMED CONSENT FORM

Title of the study: "Accuracy of bracket positioning in direct and indirect bonding techniques"

Name of the Participant: …….

Name of the Principal Investigator: C.Jegan kumar , 2nd year post graduate student , department of orthodontics , Tamilnadu Govt. Dental College & Hospital , Chennai.

Name of the Institution: Tamilnadu Govt. Dental College &Hospital, Chennai.

Documentation of the informed consent

I _____ have read the information in this form (or it has been read to me). I was free to ask any questions and they have been answered. I am over 18 years of age and, exercising my free power of choice, hereby give my consent for my ward to be included as a participant in the above said study.

1. I have read and understood this consent form and the information provided to me.

2. I have had the consent document explained to me.

3. I have been explained about the nature of the study.

4. My rights and responsibilities have been explained to me by the investigator.

5. I agree to co-operate with the investigator and I will inform him/her immediately if my ward suffers unusual symptoms.

6. I am aware of the fact that my ward can opt out of the study at any time without having to give any reason and this will not affect my future treatment in this hospital.

7. I hereby give permission to the investigators to release the information obtained from me\my ward as result of participation in this study to the sponsors, regulatory authorities, Govt. agencies, and IEC. I understand that they are publicly presented.

8. My identity will be kept confidential if the data are publicly presented.

9. I am aware that if I have any question during this study, I should contact at one of the addresses listed above. By signing this consent form I attest that the information given in this document has been clearly explained to me and apparently understood by me, I will be given a copy of this consent document.

Name and signature / thumb impression of the participant (or legal representative if participant incompetent)

_____ _____ _____

Name Signature Date

தகவல் அறிக்கை

நாங்கள் பல் சீரமைப்பு சிகிச்சைக்காக பற்களின் மீது பொத்தான் (Bracket) ஒட்டப்படும் முறைகளில் எது துல்லியமானது என்பதை அறிவதற்கான ஆய்விற்காக நோயாளிகளை தேர்வு செய்து வருகின்றோம்.

இந்த ஆராய்ச்சியில் பங்கேற்கும் நோயாளிகளின் விபரங்கள் ஆய்வு முடியும் வரை இரகசியமாக வைக்கப்படும். ஆராய்ச்சியின் முடிவு பற்றிய பதிப்புகள் அல்லது வெளியீடுகளில் யாருடைய தனிப்பட்ட விவரங்களும் பகிர்ந்து கொள்ளப்படமாட்டாது.

இந்த ஆராய்ச்சியில் பங்கேற்கும் உங்கள் முடிவு தன்னிச்சையானது. இந்த ஆராய்ச்சியில் பங்கேற்கும் எந்த நேரத்திலும் விலக்கிக் கொள்வதற்கும் உங்களுக்கு வாய்ப்பு உள்ளது. உங்களின் இந்த தீர்மானத்தினால் உங்களுக்கு இம்மருத்துவமனையில் வழங்கப்படும் பயன்களில் எவ்வித மாற்றமும் இருக்காது.

இந்த சிறப்பு ஆய்வின் முடிவுகள், இந்த ஆய்வின் முடிவில் அல்லது ஆய்வின்போது ஏற்படும் எதிர்மறையான விளைவுகளை அந்நோயாளியின் நலன் கருதியோ அல்லது சிகிச்சையளிக்கும் பொருட்டோ நோயாளிக்கு தெரிவிக்கப்படும்.

ஆய்வாளரின் கையொப்பம் **நோயாளியின் கையொப்பம்**

தேதி

<u>ஆராய்ச்சி ஒப்புதல் கடிதம்</u>

பெயர்	:	தேதி	:
வயது	:	உள் / புற நோயாளி எண்	:
பால்	:	ஆராய்ச்சி சேர்க்கை எண்	:

ஆய்வாளர் : **செ.ஜெகன்குமார்,** 2ம் ஆண்டு முதுநிலை மாணவர்
பல் சீரமைப்புப் பிரிவு, தமிழ்நாடு அரசு பல் மருத்துவமனை,
சென்னை-3.

தமிழ்நாடு அரசு பல் மருத்துவக் கல்லூரியின் பல் சீரமைப்புத் துறையில் பல்சீரமைப்பு சிகிச்சைக்காக பற்களின் மேல் ஒட்டப்படும் பொத்தான் (Bracket) பற்றிய ஆய்வு.

என்னுடைய சுய நினைவுடனும் மற்றும் முழு சுதந்திரத்துடன் இந்த மருத்துவ ஆராய்ச்சியில் சேர்த்துக்கொள்ள ஒப்புதல் அளிக்கிறேன்.

கீழ்காணப்படும் நிபந்தனைகளுக்கு நான் ஒப்புதல் அளிக்கிறேன்.

இந்த ஆராய்ச்சியின் நோக்கமும், சிகிச்சை முறைகளும் எனக்கு திருப்தியளிக்கும் வகையில் அறிவுறுத்தப்பட்டது.

இந்த ஆய்வானது பல் சீரமைப்பு சிகிச்சைக்காக பற்களின் மீது பொத்தான் (Bracket) ஒட்டப்படும் முறைகளில் எது துள்ளியமானது என்பதை அறிய மேற்கொள்ளப்படுகிறது என்பதை அறிந்துகொண்டேன்.

என் உடல்நலம் பாதிக்கப்பட்டாலோ அல்லது எதிர்பாராத வழக்கத்திற்கு மாறான நோய்க்குறி தென்பட்டாலோ அதனை உடனடியாக மருத்துவரிடம் தெரிவிக்க சம்மதிக்கிறேன்.

என் மருத்துவ குறிப்பேடுகளை இந்த ஆராய்ச்சியில் பயன்படுத்திக்கொள்ள சம்மதிக்கிறேன். இந்த ஆராய்ச்சி மையமும், ஆராய்ச்சியாளரும் என்னுடைய விவரங்கள் அனைத்தையும் இரகசியமாக வைப்பதாக அறிகிறேன்.

…….	…….	…….
நோயாளியின் பெயர்	கையொப்பம்	தேதி
…….	…….	…….
நோயாளியின் பெற்றோர் பெயர்	கையொப்பம்	தேதி
…….	…….	…….
ஆராய்ச்சியாளரின் பெயர்	கையொப்பம்	தேதி

INSTITUTIONAL ETHICAL COMMITTEE

Tamil Nadu Government Dental College and Hospital, Chennai - 3
Telephone No. 044 2534 0343
Fax 044 2530 0681

Ref No 0430/ DE/ 2010 Date: 26.11.2012

Title of the work: "Accuracy of bracket positioning in direct and indirect Bonding techniques"

Principal investigator: Dr.C.Jegan Kumar,
II Year MDS

Department : Orthodontics,
Tamil Nadu Government Dental College and Hospital, Chennai - 3

The request for an approval from the Institutional Ethical Committee (IEC) considered on the IEC meeting held on 30-04-2012 at the Principal's Chambers Tamil Nadu Government Dental College and Hospital, Chennai – 3 and subsequent to your modification letter dated 26.11.2012

"Advised to proceed with the study"

The Members of the Committee, the secretary and the Chairman are pleased to approve the proposed work mentioned above , submitted by the principal investigator.

The principal investigator and their team are directed to adhere the guidelines given below:

1 .You should get detailed informed consent from the patients / participants and maintain confidentiality

2. you should carry out the work without detrimental to regular activities as well as without extra expenditure to the Institution or Government.

3 You should inform the IEC in case of any change of study procedure , site and investigation or guide.

4. You should not deviate from the area of work for which you have applied for ethical clearance

5. You should inform the IEC immediately in case of any adverse events or serious adverse reactions. You should abide to the rules and regulations of the institution (s)

6. You should complete the work within the specific period and if any extension of time is required, you should apply for permission again and do the work.

7 .You should submit the summary of the work to the ethical committee on completion of the work.

8. You should not claim funds from the Institution while doing the work or on completion.

9.You should understand that the members of IEC have the right to monitor the work with prior intimation

10. Your work should be carried out under the direct supervision of your Guide / Professor.

S Nyachiar 26/11/12
SECRETARY

26/11/12
CHAIRMAN